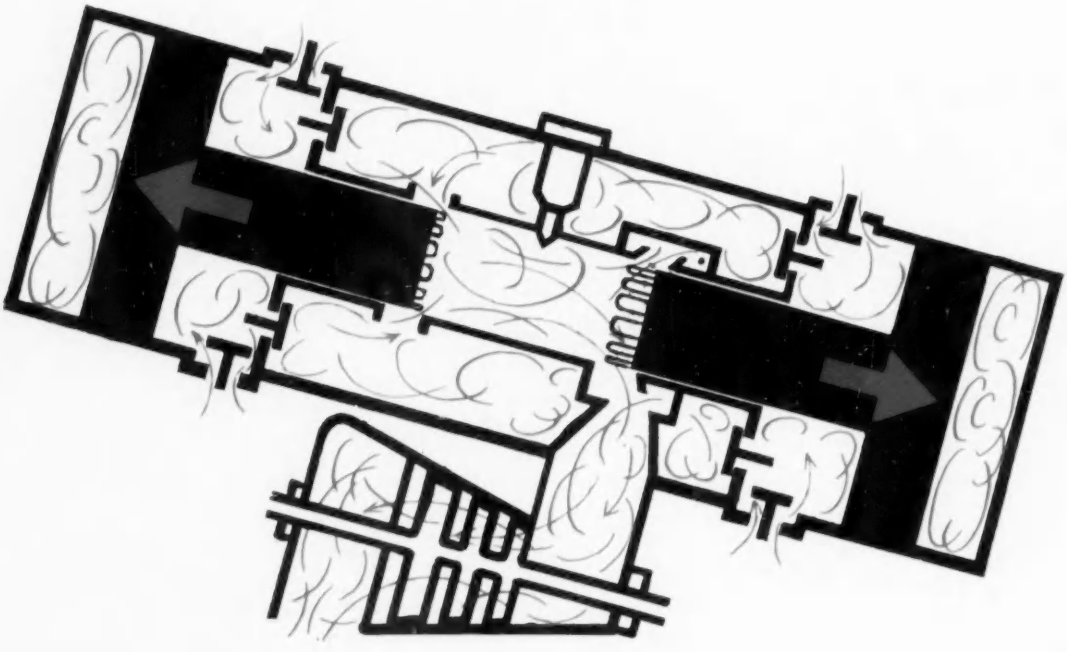
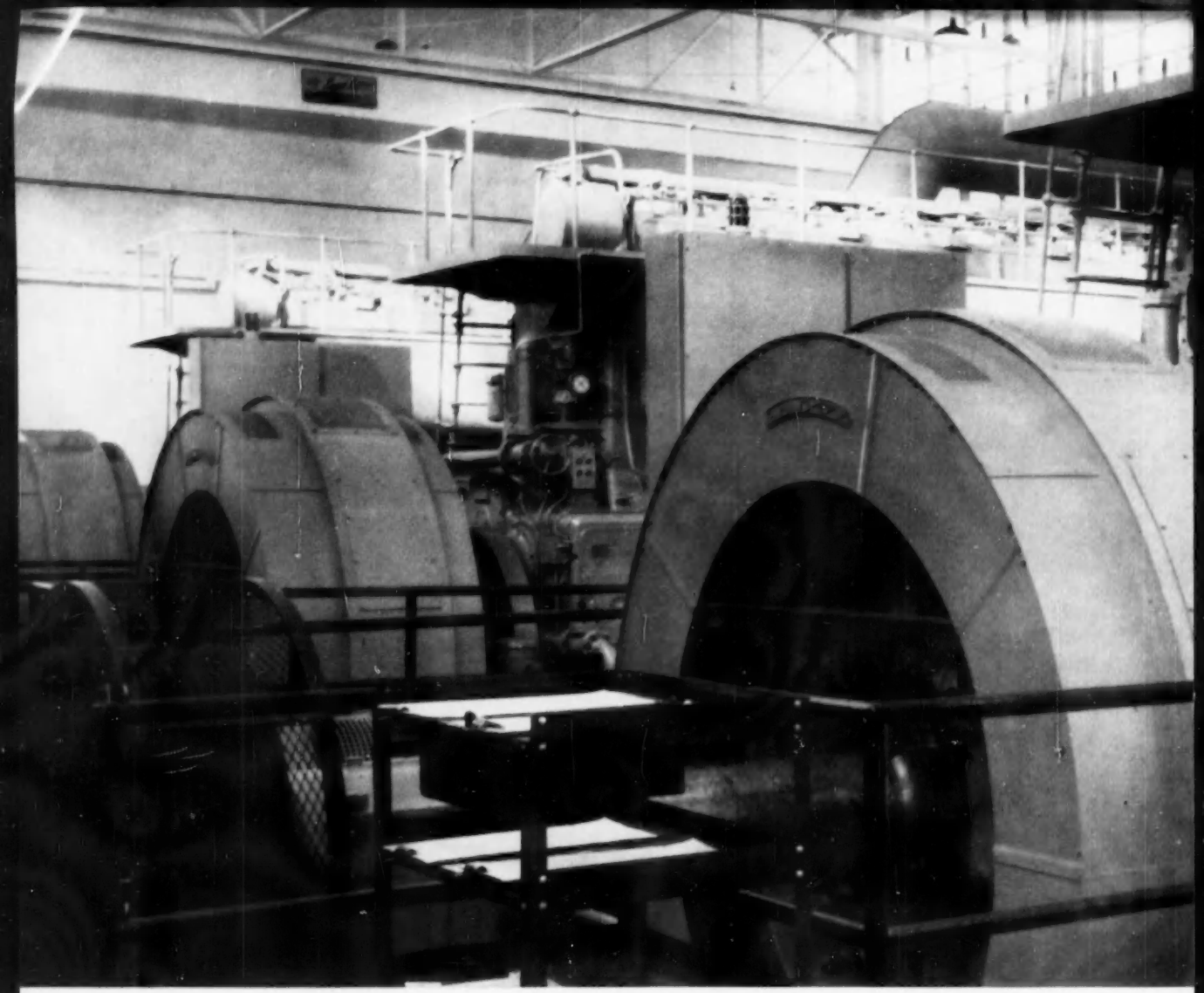
diesel power

August 1956



free-piston engine-gas turbine tested for vehicular use



Why TEXACO URSA does a better diesel

ADVANCES in diesel engine design and the imposition of heavier loads have introduced new and complicated lubrication problems. *Texaco Ursa Oil Heavy Duty* is specifically designed to overcome them.

Texaco Ursa Oil Heavy Duty is specially distilled from choice paraffinic stocks, dewaxed and solvent refined to remove gums, tars and oxidation-forming products. Then, this great oil is further improved by effective Texaco additives which:

1. **Inhibit oxidation**
2. **Assure full detergency and dispersion**
3. **Prevent rust**
4. **Protect bearings**
5. **Withstand high pressure and temperatures**

TEXACO

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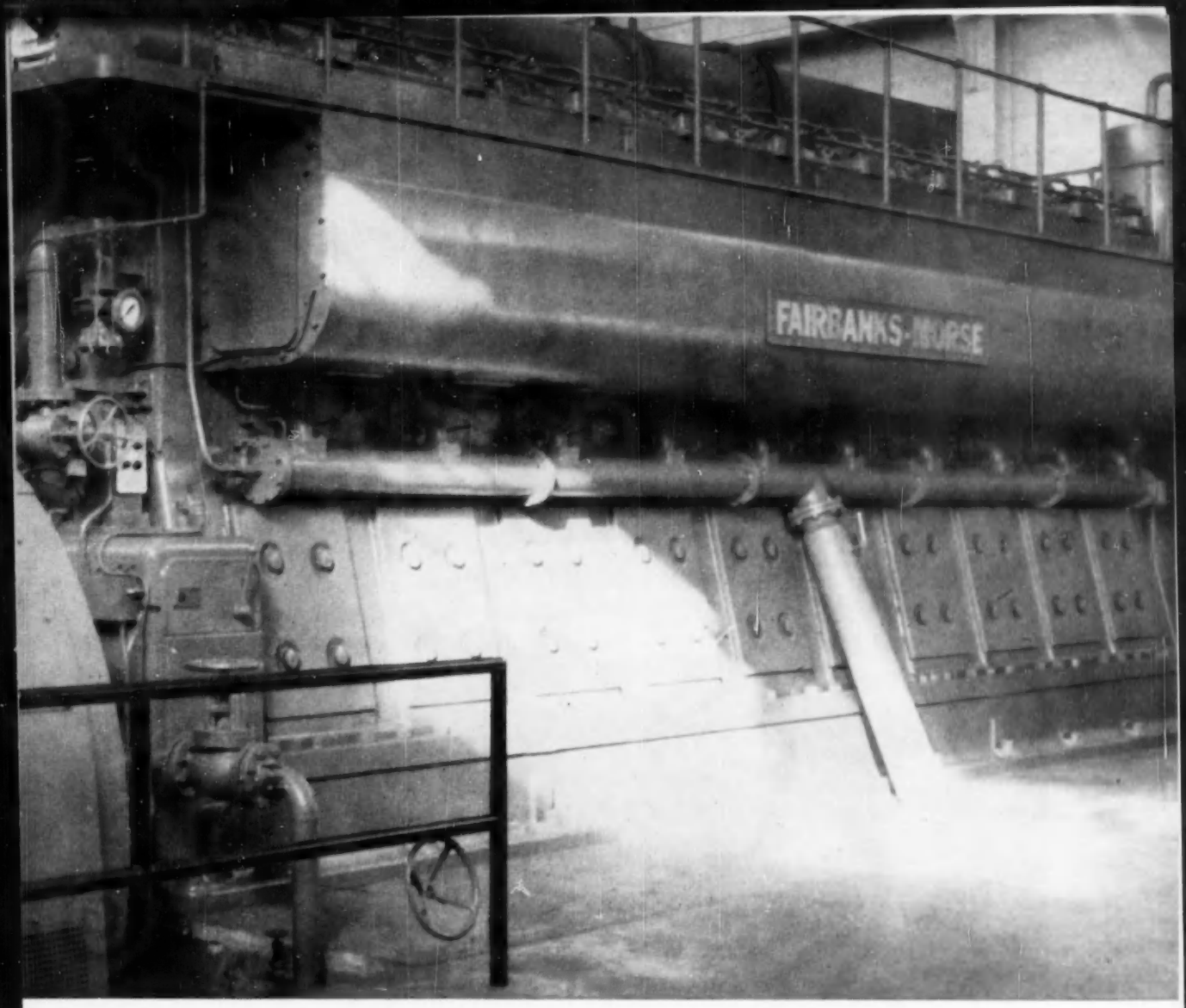

OIL HEAVY DUTY
lubricating job...

6. Minimize wear
7. Lower pour point
8. Reduce foaming

Texaco Ursa Oil Heavy Duty thus assures ideal engine cleanliness . . . no harmful deposits, rings always free, dependable action of fuel injectors and pumps . . . resulting in delivery of *more power* with *less fuel* over *longer periods* between overhauls.

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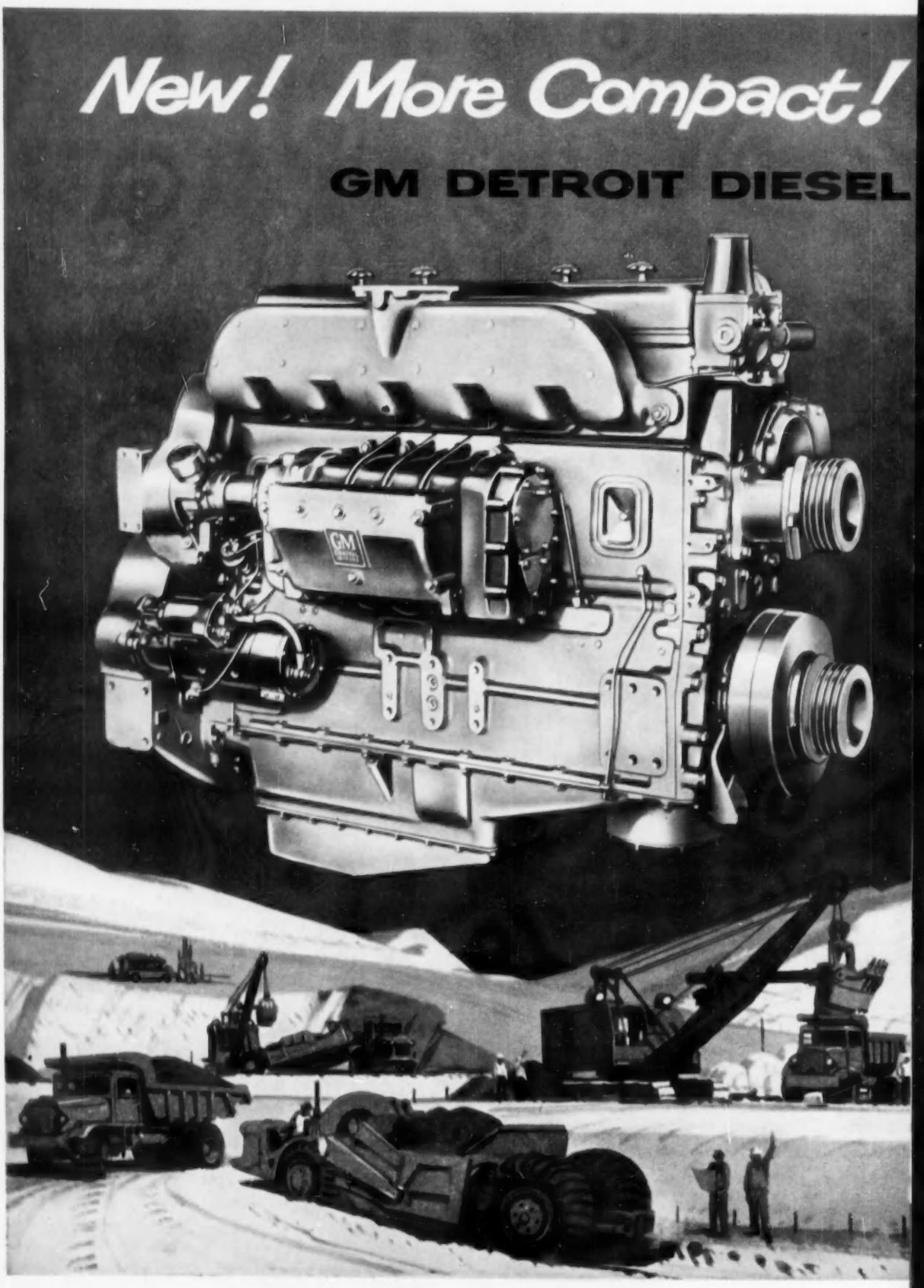

New! More Compact!
GM DETROIT DIESEL

More Versatile!

300-H.P. SERIES 110 ENGINE

Now available to fit a broader range of power equipment

Now the best 300-horsepower Diesel is even better than ever—ready to step up production and cut costs on any job you name.

It's the time-proved General Motors Series 110 Diesel, newly equipped with a side-mounted blower similar to the one used on the famous 71 Series. It's a more compact engine. It's shorter. It's lower. It fits more applications than ever before.

You can have this new GM Detroit Diesel Series 110 engine installed in off-highway trucks and move bigger loads faster.

You can use it to increase the power of heavy crawler tractors, scrapers and air compressors—get more work per day and per dollar.

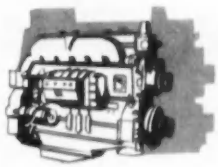
And, in practically no time at all, you can have this new Series 110 Diesel installed in almost any 3-yard shovel—to move earth faster at less cost.

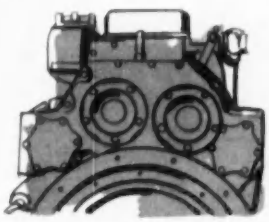
The new blower makes the Series 110 engine far more versatile—available with *either* right- or left-hand rotation, and a wider range of accessory drive outlets—*four* accessory drives on the rear of the engine, and *four* fan-mounting positions on the front.

This new Detroit Diesel Series 110 engine takes on all comers in operating efficiency. It's a leader in work output per dollar. Let your local GM Detroit Diesel Distributor or Dealer show you what we mean.

New Compactness—

The side-mounted blower eliminates former style blower at the end of the Series 110 engine and also cuts down height. Easier to install—easier to maintain.



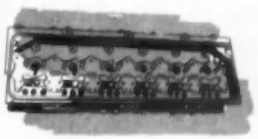


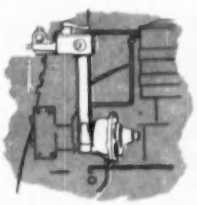
New Flexibility—

Four accessory drive outlets on rear of engine. You can direct drive both a hydraulic pump and an air compressor off the engine at the same time. New gear train features wider gears with increased helix angle for longer life. Blower and camshaft loads are split.

New long-life Cylinder Head

Has many design improvements, including integral water manifold and drilled passages for rocker-arm lubrication. Water manifold studs and gaskets eliminated. Outside rail gives extra rigidity.





New Governor

Is more easily serviced—utilizes many Series 71 parts. Provides for tachometer drive. An accessory drive may also be taken off the governor drive gear.

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Engine Division of General Motors, Detroit 28, Michigan

Single Engines . . . 30 to 300 H.P. Multiple Units . . . Up to 893 H.P.

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diesel power

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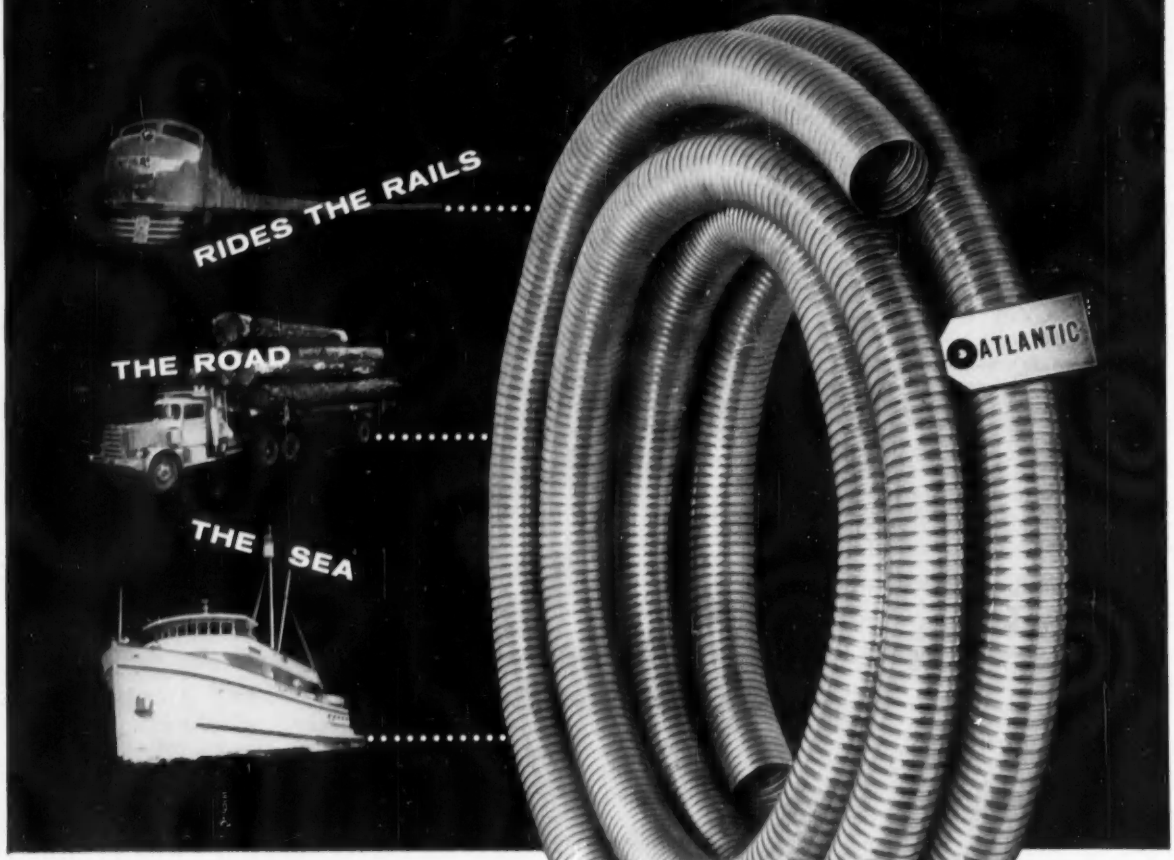
atlantic

FLEXIBLE METAL HOSE

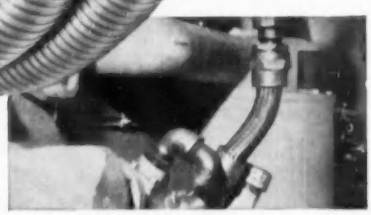


When diesels power trucks hauling 70,000 lb. loads of logs over mountain roads — or locomotives and ships, Atlantic flexible metal hose is usually given the job of guarding those vital diesel life lines—water, fuel, exhaust.

Atlantic flexible metal hose is manufactured to tough specifications.

Wall thickness is absolutely uniform. Tight against water, oil, steam, gas and air. Requires no maintenance. Atlantic flexible metal hose dampens vibration, remains flexible at higher temperatures.

There is an Atlantic flexible metal hose for each of these applications. Made in bronze, steel, stainless and monel—⅛"-36" I.D. with required fittings.



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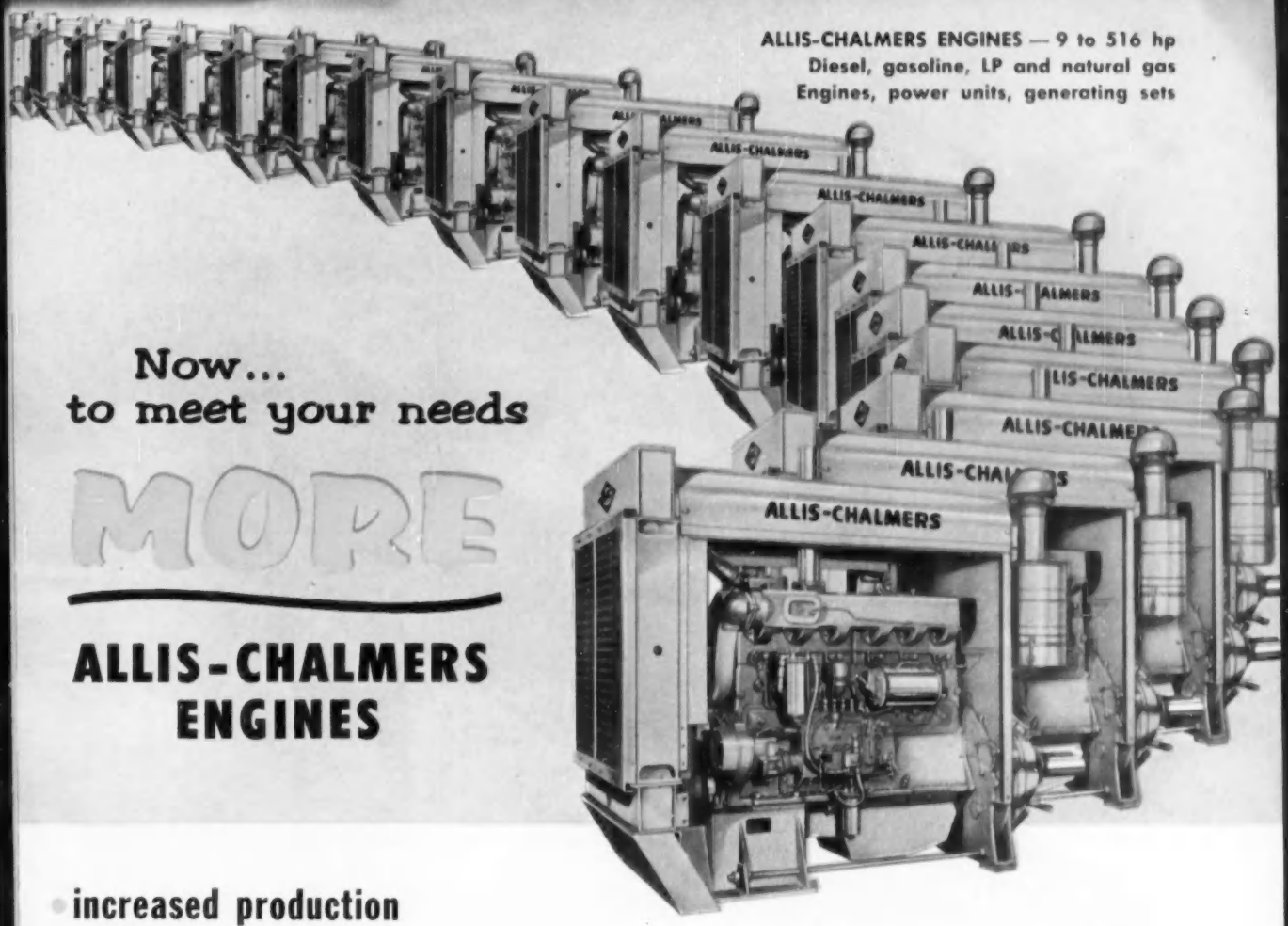
Diesel, gasoline, LP and natural gas
Engines, power units, generating sets



Now... to meet your needs

MORE

ALLIS-CHALMERS ENGINES

- **increased production**
- **improved standards**
- **expanded service**
- **greater parts availability**
- **more parts interchangeability**

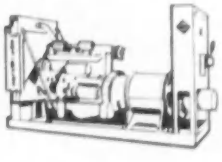
The production of Allis-Chalmers engines goes up, up, up to meet your needs. The 1956 production is expected to reach an all-time high — and 1955 output was many percent greater than 1954's. A multi-million-dollar expansion of facilities will further boost production.

But there are not only *more* engines to meet your needs, there are *better* engines — as Allis-Chalmers research and development continues to pioneer improvements, and as production and inspection standards are set even higher.

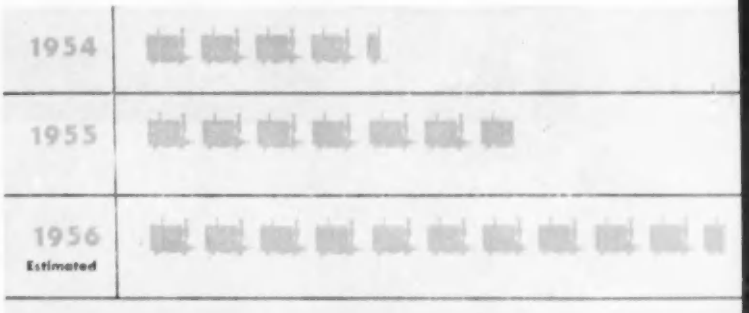
Along with this comes an expansion of customer service and greater parts availability, too, as sources of parts and service are moved closer to you.

More and more, it's Allis-Chalmers engines and service to meet your needs.

ALLIS-CHALMERS, BUDA DIVISION, MILWAUKEE 1, WISCONSIN



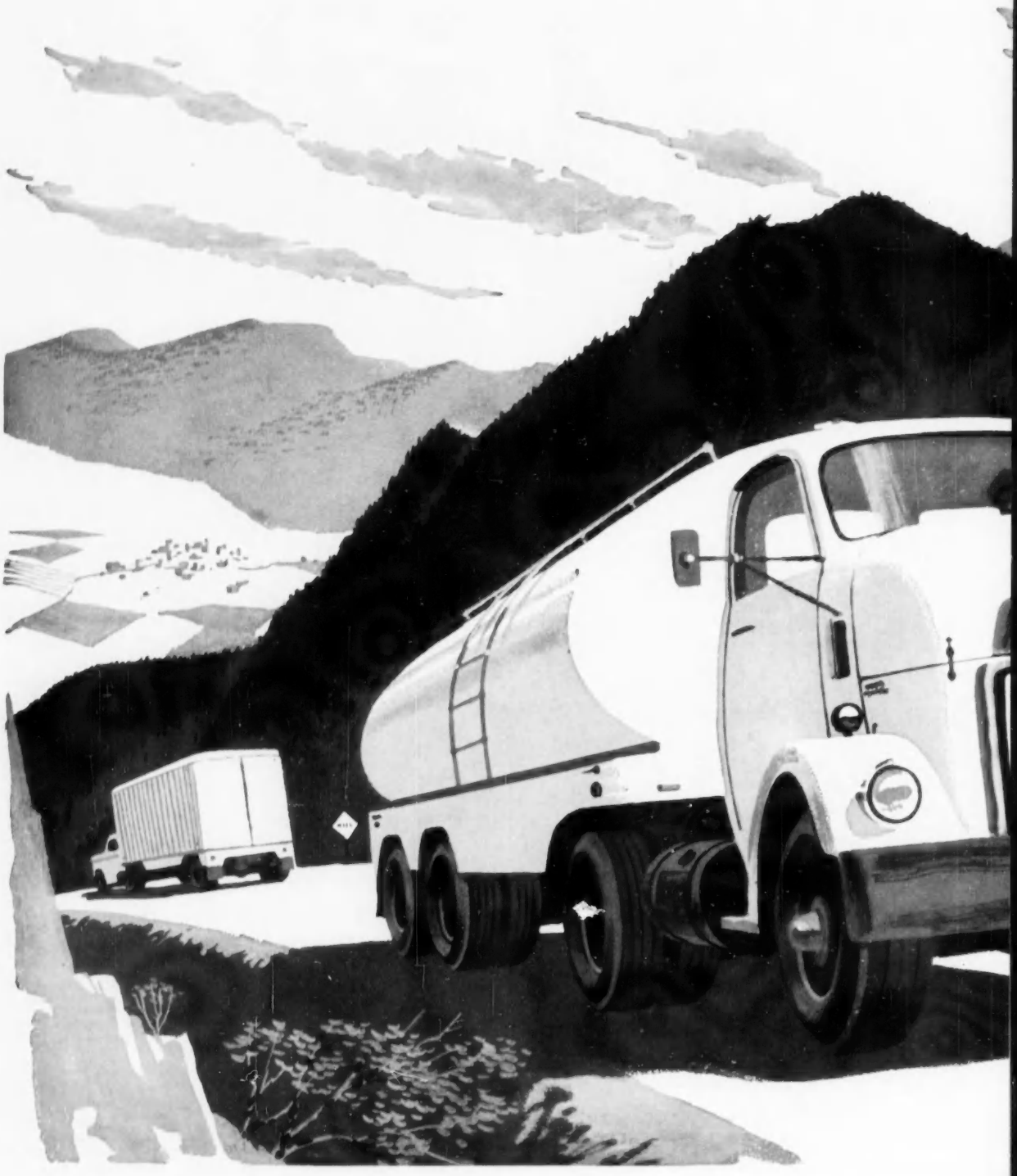
A complete line of improved engine generator sets from 5 to 300 kw, for emergency and continuous duty, for marine, cooling tower and industrial use.



The 1956 production of Allis-Chalmers engines will reach an all-time high, with output many percent higher than in previous years.

ALLIS-CHALMERS

BE-3



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Every unit in Delco-Remy's famous heavy-duty line is designed and built to take the day-in-day-out pounding of over-the-road operation . . . to give many thousands of miles of dependable service.

For example, Delco-Remy 5½-inch diameter heavy-duty D.C. generators include such long-life features as extra-large commutator and brushes (brush life of 100,000 miles is common), ball bearings, wick-type lubrication with oilers, and forced ventilation. These generators are available, with matching regulators, in a wide variety of voltage ratings and output capacities.

Other specially-designed Delco-Remy heavy-duty units include cranking motors, coils and other ignition components, and Delco long-life Extra-Duty batteries with rubber separators and Delcoloy grids.

For more dependable service with minimum downtime, specify Delco-Remy heavy-duty electrical equipment when you order new vehicles or modernize your present ones. Complete details on Delco-Remy heavy-duty electrical equipment are available through your nearest General Motors car or truck dealer, or the United Motors System.

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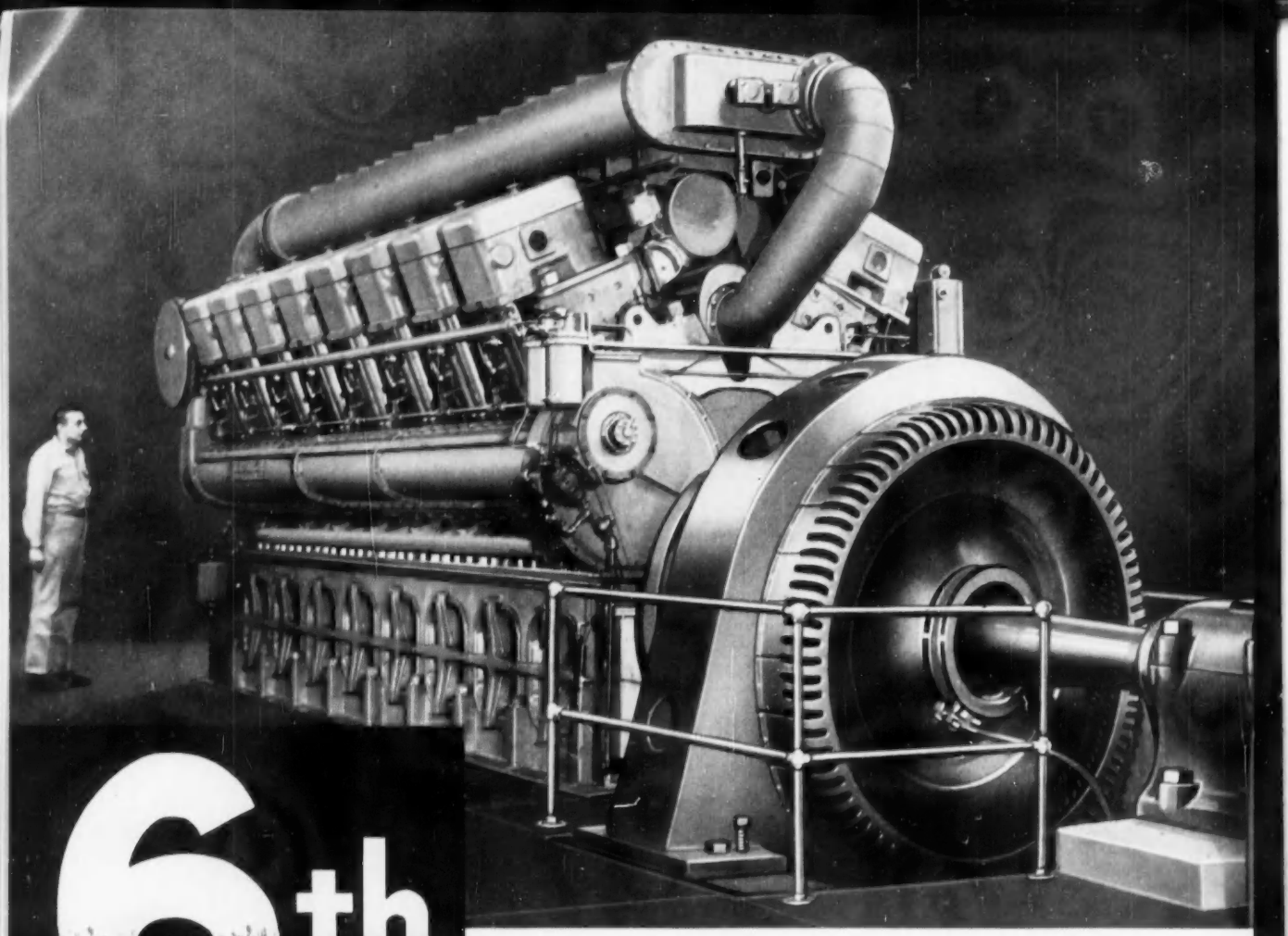
STARTING WITH **Delco-Remy** ELECTRICAL SYSTEMS



6th NORDBERG ENGINE for Neodesha, Kansas

"HIGHLIGHTS" OF POWER PLANT GROWTH

1922—Installed 2 Nordberg 550 hp engines in Neodesha plant.

1934—Installed Nordberg 880 hp engine.

1946—Installed Nordberg 1620 hp engine.

1952—Installed Nordberg 1750 hp engine.

1956—Sixth Nordberg engine to be installed . . . a 16 cylinder V-type *Supairthermal*® Duafuel engine rated 3150 bhp, 2250 kw.

Dependable engine performance builds repeat orders . . . and a case in point is the fact that the City of Neodesha, Kansas, has now ordered its *sixth* Nordberg engine. As an example of the kind of performance these engines deliver, here are some of the figures taken from operating records kept on Neodesha's fifth Nordberg engine—a 1750 bhp, 1235 kw Duafuel® unit.

According to Everett Powell, Superintendent, Neodesha Electric & Water Plants, from February 14, 1952, the date this engine was put on the line to March 1, 1956, a period of just over four years, it has run 34,370 hours out of a possible 35,784 . . . which means that this engine has operated over 96% of its total installed hours without even removing a piston or cylinder head—a most outstanding record. In compiling this record, the engine has been producing approximately 88% of total plant production. With performance like that, it was natural that city officials again chose Nordberg to meet increased demands. Their sixth Nordberg unit, shown above is a 16 cylinder *Supairthermal* engine rated 3150 bhp, 2250 kw.

For engines to meet *your* power needs write Nordberg . . . *pioneer in the building of heavy duty engines from 10 to over 12,000 hp.*

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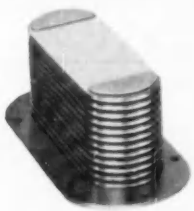
Harrison helps move the earth . . . by making heat bite the dust! High-powered shovels—driven by Detroit Diesel 2-cycle engines—turn in dependable, low-cost performance when Harrison's on the job controlling the heat. You'll find Harrison heat control equipment on many of the nation's leading diesels and other power equipment. For manufacturers know they can depend on Harrison—with over 45 years' experience in manufacture, design and engineering research. If you have a cooling problem, look to Harrison for the answer.

GM



HARRISON

RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N.Y.

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PACEMAKER 150-T

Recommended for pressure-circulation systems of direct-connected steam turbines, and for the bearings of turbo-generators where pressure-circulation of the oil is employed.

PACEMAKER 300-T

For use in the lubrication of steam turbines with single reduction gear units. Also for the lubrication of high-speed, ring-oiled, auxiliary turbines, where operating temperatures are not above 200°F.

PACEMAKER 400-T

Recommended for the lubrication of propulsion turbine units on naval and commercial vessels, in pressure-circulation systems.

PACEMAKER 500-T

Suitable for the lubrication of ring-oiled bearings of auxiliary turbines where operating conditions require an oil of heavier body than Pacemaker 300-T. Also recommended for use in separately lubricated turbine gear reduction units.

PACEMAKER 750-T

Recommended for the lubrication of high-speed, ring-oiled, auxiliary turbines, where operating temperatures are in excess of 200°F., and use of a heavier bodied oil is required.

CITIES SERVICE DIESEL OILS

Made in the world's most modern lubricating oil refinery at Lake Charles, Louisiana, Cities Service Diesel Oils are blended from highest quality, high V.I. mineral oils and fortified with specially developed additives. There's a Cities Service Diesel Oil tailored for top performance in every type of diesel operation.

D-C 300 SERIES

These oils are designed to fully conform to Military Specification MIL-L-2104A. Made from the finest base oils, they are strongly fortified against oxidation and corrosion. They have the necessary detergent-dispersant properties to insure superior lubrication performance in high speed Diesel engines operating under heavy duty service.

Recommended for service DG under A.P.I. classification system.

D-C 100 SERIES

These oils are designed to conform to U. S. Army Specification 2-104B (Supplemental List 1). They are also known as Superior Lubricants Series 1 and are intended for more severe service than the D-C 300 Series Oils. Particularly recommended for the lubrication of medium and high-speed Diesel engines using lower quality fuels.

Recommended for service DM under A.P.I. classification system.

D-C 500 SERIES

These oils meet the requirements of The Caterpillar Tractor Company for a "Superior Lubricant (Series 3)". They have the highest level of detergent-dispersant action with maximum oxidation and corrosion protection to assure reliable operation of Diesel engines under most severe service conditions or where low quality fuels of very high sulphur content are used.

Recommended for service DS under A.P.I. classification system.

PACEMAKER SERIES

The new Pacemaker line of Diesel engine oils is made from the same high quality base oils as are the Pacemaker T Series, and contains similar additives, but in lesser amounts. These oils are adaptable for use in many low and medium speed stationary engines operating under conditions which would not require the use of heavier fortified oils, such as the Pacemaker T Oils.

PACEMAKER T SERIES

These are medium duty, high grade, high V.I. oils fortified against oxidation, rust and foam. Admirably suited for slow and medium speed engines employing the dry sump system of lubrication and operating under conditions where the service is not severe enough to benefit from a full heavy duty oil.

NEPTUNE 9000 SERIES

Designed specifically for lubrication of marine-type Diesel engines, both military and commercial.

Neptune 9000 Series Oils are made from high quality, high V.I. solvent refined stocks and are strongly fortified against oxidation and corrosion. They are specially inhibited against silver alloy bearing corrosion and have the necessary detergent-dispersant properties to give maximum performance under severe operating conditions.

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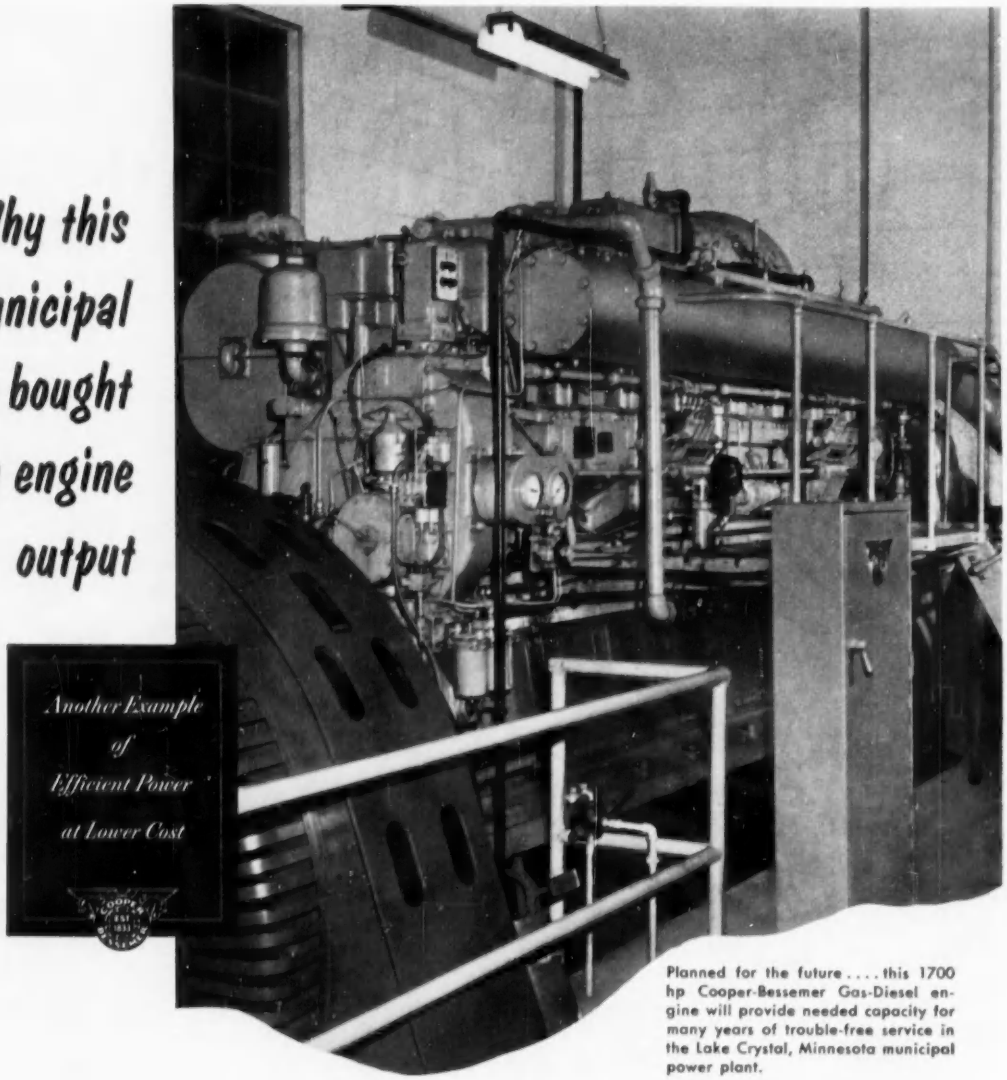
Assurance of Quality

Your NAPA Jobber is a Good Man to Know!

Why this small municipal plant bought extra engine output



Planned for the future . . . . this 1700 hp Cooper-Bessemer Gas-Diesel engine will provide needed capacity for many years of trouble-free service in the Lake Crystal, Minnesota municipal power plant.

● Lake Crystal, Minnesota carefully studied the matter, installed a high output Cooper-Bessemer engine, and they're far from sorry. This small community enjoys substantial savings from a 1200 kw. . . . 1700 hp. . . . 155 bmep Gas-Diesel engine.

The engine, a supercharged Cooper-Bessemer JS, boasts an enviable "around the clock" operational record with excellent fuel economy maintained under heavy *or* light loads. With the installation of this new unit, there's no further need for riding an engine at costly, inefficient loading in anticipation of sudden heavy increases.

Although oversized for present needs, this 8 cylinder Cooper-Bessemer will more than justify its original cost. Dependable, economical power will be available for many future years. And as Lake Crystal power demands grow . . . this JS will easily handle the increased load. No need for costly plant expansions. No new engines to buy.

Impressive month by month operating cost records of Lake Crystal municipal are available upon request. Write The Cooper-Bessemer Corporation, Mount Vernon, Ohio.

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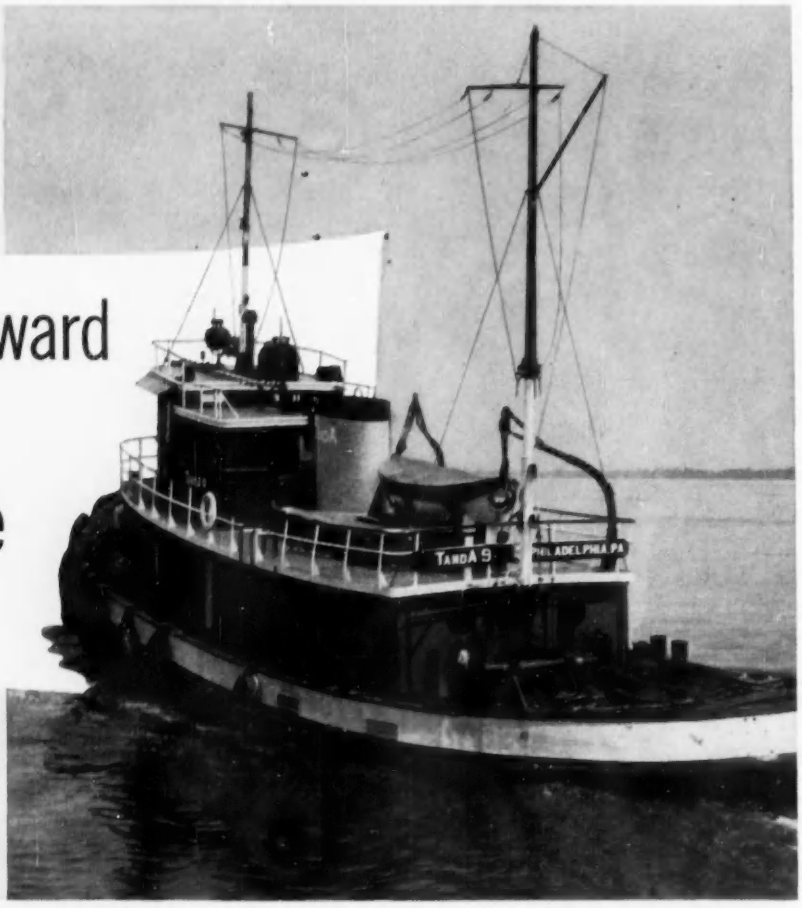
C/R Shaft and End Face Seals • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears



heading toward a long trouble-free life . . .

with

GULF DIESELMOTIVE and GULF DIESELECT

The powerful Atlas-Imperial Engine in this tug of the Taylor & Anderson Towing & Lighterage Company, Philadelphia, Pa., is on a true course toward dependable and economical operation with the ideal combination for workboat diesels —Gulf Dieselmotive and Gulf Dieselect.

GULF DIESELMOTIVE—the lubricating oil that has an unmatched record of low maintenance costs in this tough service. Here's why: Chosen for their ability to prevent hard carbon deposits in hot spots, the selected base stocks of Dieselmotive oil also provide an oxidation resistance safety factor. Its 100% solvent refining (which removes undesirable constituents) guarantees greater stability and more effective bearing protection. And Dieselmotive's superior additive response is obtained by carefully matching the additives to the base stocks. This insures clean rings and grooves, a minimum of piston crown deposits.

GULF DIESELECT—the straight run distillate fuel that burns evenly and completely, thus contributing further to engine cleanliness. And Gulf Dieselect has a high Cetane Index to assure good combustion at all speeds.

This combination of top quality lubricating and fuel oils can deliver more hours of operation between ring jobs, and lower maintenance costs for your fleet.

Contact your nearest Gulf office for more complete information on these quality products.

GULF

GULF OIL CORPORATION • GULF REFINING COMPANY

1822 Gulf Building, Pittsburgh 30, Pa.

THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS

MaK

MARINE DIESEL ENGINES UP TO 2000 HP

For coastal shipping and trans-continental service for single- double- and 4 engine propulsion units.

The type M 582 engines are equipped with light alloy pistons for better heat dissipation.

"9 and 10 cylinder engines—upper picture—have parted cylinder blocks and two-parted crankshafts. All components are amply dimensioned for heavy duty. Special leaflets on request."

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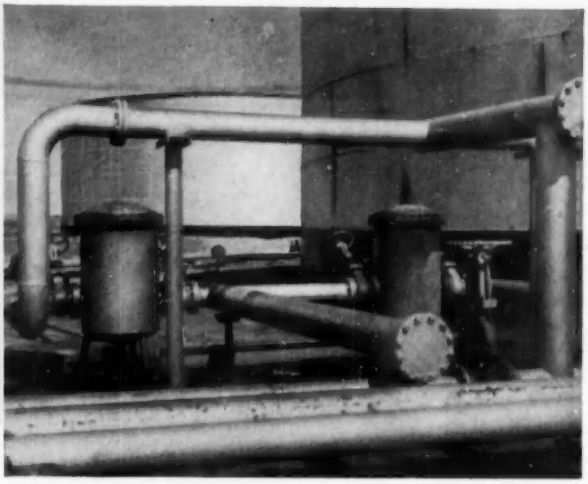
GERMANY

at the curb new Purolator dual fuel filter, PAG-25D, has a high flow rate of 25 GPM for diesel fuel combined with virtually no pressure drop. A final assurance to every customer that your product is clean.

or

at the terminal large bulk filtration equipment like this pedestal-type filter (PAG-300L to 1200L) can be used at high flow rates of from 300 to 1200 GPM. Reduces meter wear.



Purolator micronic® fuel filters remove rust

Despite rigid checks which prove the purity of fuel as it leaves the refinery, subsequent corrosion in storage tanks and pipes frequently contaminates it with particles of iron oxide. To remove rust particles, Purolator's engineers have developed the world's finest line of bulk filtration equipment. A recent addition to this line is Purolator's new curb pump filter. It has a filtration area of over 1800 square inches, achieved by 2 resin impregnated micronic fuel filters operating in parallel. Its development helps make certain that wherever you filter diesel fuel or gasoline ...at the curb or at the terminal...you can get precisely the right filter from Purolator.

PUROLATOR

"FIRST IN THE FIELD OF FILTERING"

For full details, write
Purolator Products, Inc.,
Front and Linden Streets
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WOODWARD GOVERNORS for ENGINES and TURBINES

DIESEL LOCOMOTIVE MODEL OF PG GOVERNOR

This governor is one of several hundred variations of the basic PG governor.

It is used on the engines of diesel-electric locomotives. Movement of the engineer's throttle lever sets the governor (electrically or pneumatically) for the desired engine speed.

The governor then senses whether the engine is carrying more or less load than required for maximum fuel economy at that speed, and automatically adjusts generator excitation to bring the load to that value.

For economy and simplicity of installation, the governor illustrated has the load control rheostat and servomotor to operate it mounted as an integral part, though these are often mounted separate from the governor. With simple modifications (usually just omitting parts) this same mass-produced governor is used for a variety of special applications. These include automatic control of prime movers driving boiler feedwater pumps, forced and induced draft fans, pipeline pumps or compressors, refrigeration compressors, air and gas compressors in chemical and petroleum processing plants and steel mills, oil well drilling, and marine engines (including automatic control of variable pitch propellers for best efficiency).

Thousands of PG governors have been in service for many years . . . positive proof that they give long, trouble-free operation. When an overhaul is finally needed, it is usually done by using our convenient, fast, economical unit exchange plan.

WRITE FOR DETAILS ON OUR UNIT EXCHANGE PLAN
Give serial number of typical governor when requesting any information.

WOODWARD GOVERNOR COMPANY
ROCKFORD, ILLINOIS

WORLD'S OLDEST AND LARGEST MANUFACTURER OF HYDRAULIC GOVERNORS EXCLUSIVELY

TWINSURANCE

FOR ALL DIESELS

FRAM WATER SEPARATOR AND FUEL FILTER REMOVES ALL WATER—TRAPS DIRT AND DUST!

A FRAM Water Separator and Fuel Filter will give your fuel injectors complete protection by:

1. Removing *all* water to save injectors from pitting and corrosion!
2. Trapping dangerous dirt to end abrasive action once and for all!

For longer life, less wear, fewer repairs—guard *each* diesel with a FRAM Water Separator and Fuel Filter! For complete details write to: FRAM CORPORATION, Providence 16, R.I. or to Fram Canada Ltd., Stratford, Ontario.

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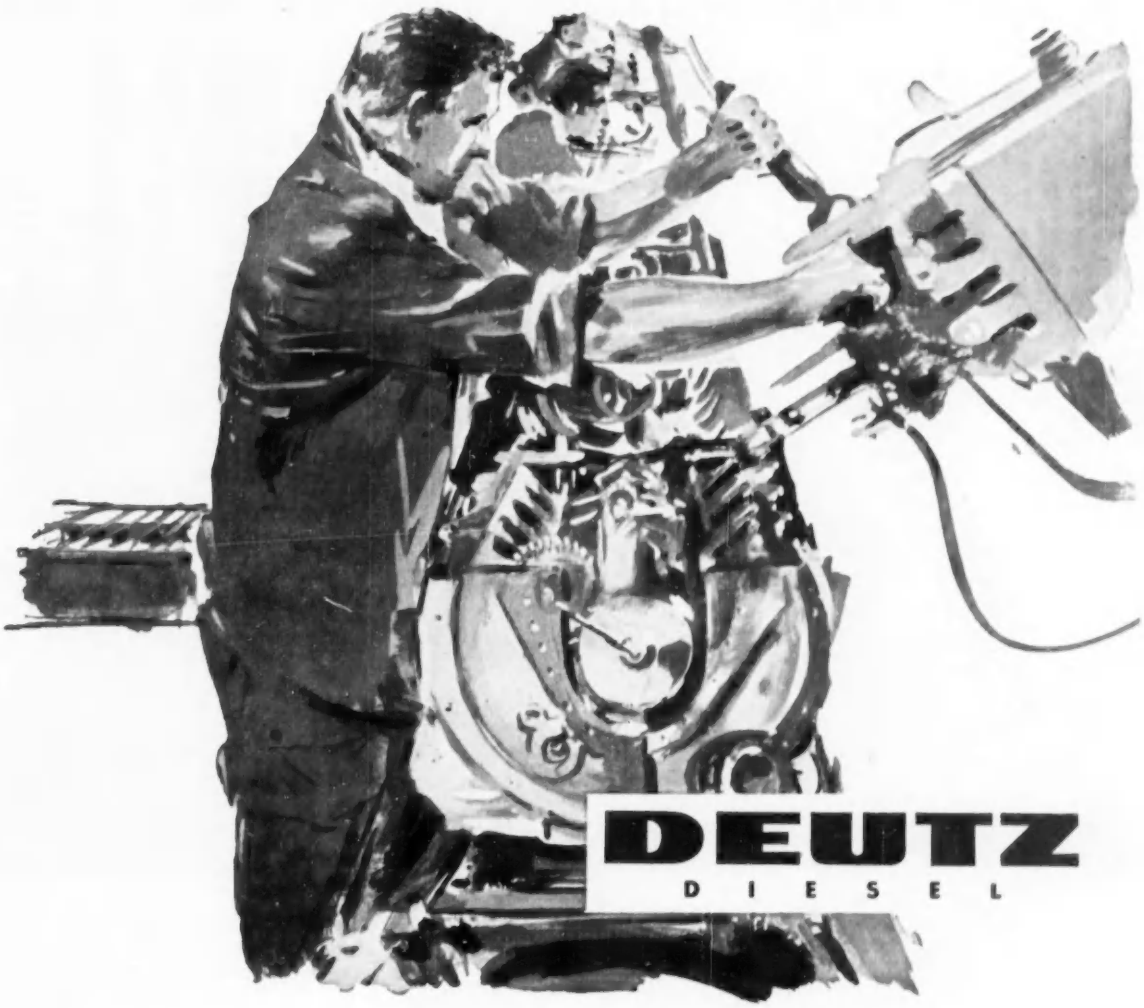
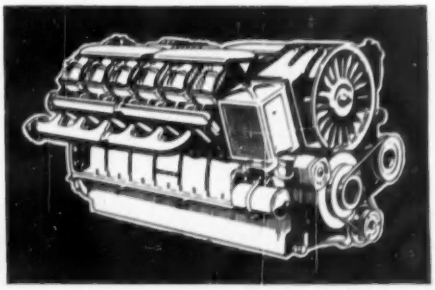
OIL • AIR • FUEL • WATER
FILTERS

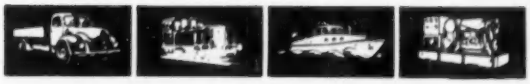


DEUTZ
DIESEL

air-cooled

began in 1948 to build air-cooled diesel engines in large series. 7 years after, in 1955, the oldest engine manufacturers in the world had built and sold 150.000 air-cooled DEUTZ diesel engines totalling 7.5 Million B.H.P. These equipment engines are used all over the world for every kind of application. DEUTZ builds air-cooled 1 to 12-cylinder diesel engines with an output range from 5 to 250 B.H.P. for road vehicles, rail vehicles, water craft, working machines in all fields of application, generator sets for stationary and mobile electric and power plants.



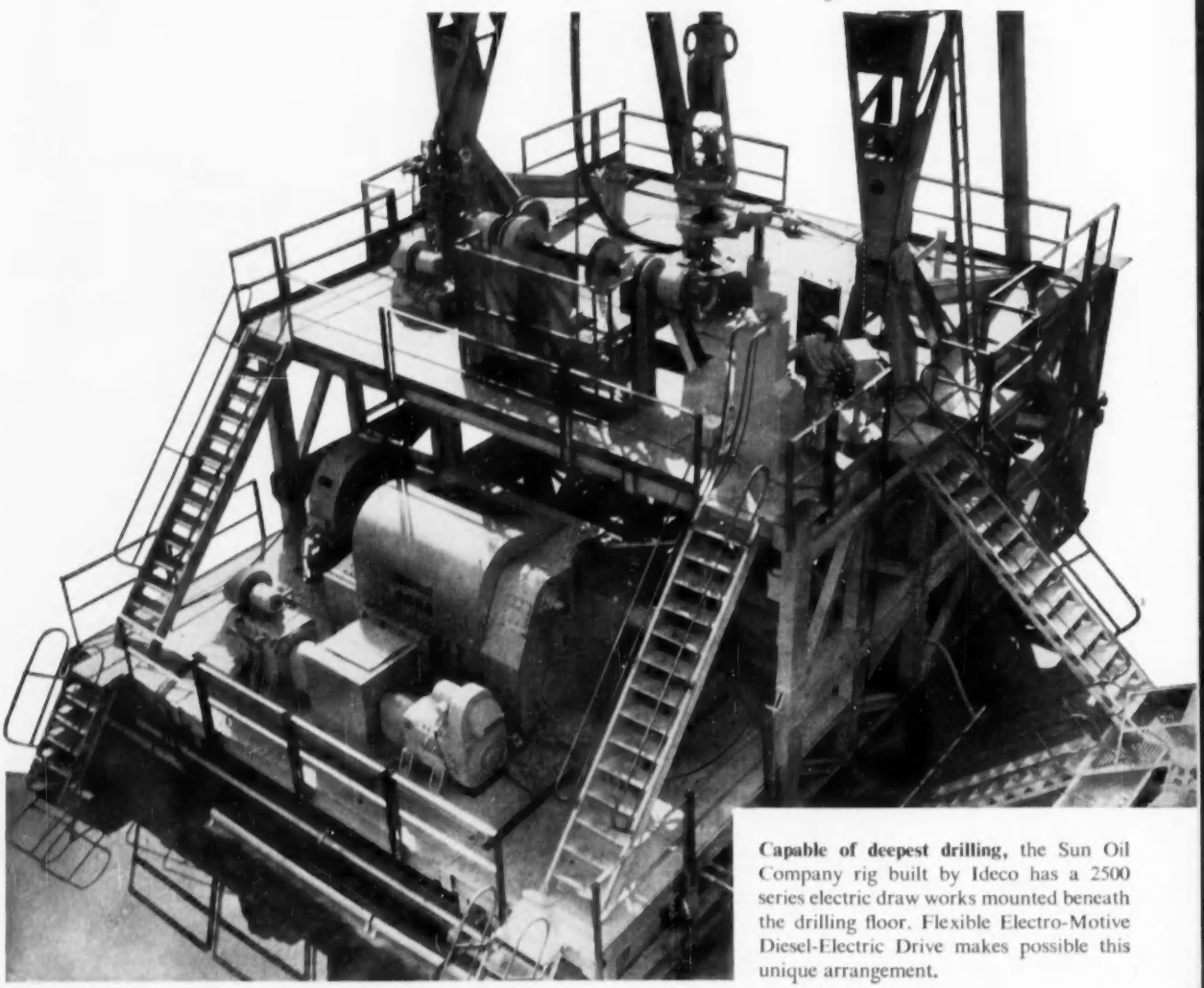


KLÖCKNER-HUMBOLDT-DEUTZ AG. KÖLN

GERMANY

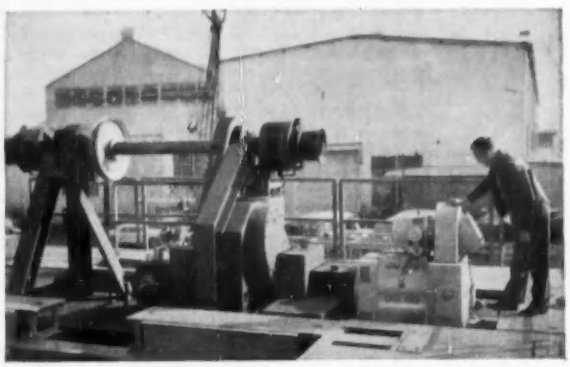
U. S. REPRESENTATIVE: DIESEL ENERGY CORPORATION, 82 BEAVER STREET, NEW YORK 4, N. Y.

It's the cleanest, most



Capable of deepest drilling, the Sun Oil Company rig built by Ideco has a 2500 series electric draw works mounted beneath the drilling floor. Flexible Electro-Motive Diesel-Electric Drive makes possible this unique arrangement.

B. H. Hefner, Chief Electrical Engineer of Electro-Motive Division (center), discusses application of GM Diesel-Electric Drive with "Buck" Wilder of Sun Oil Company (left) and W. O. Cook, Vice-President of Ideco.



Newell B. Collins, Electro-Motive Service Engineer, inspects arrangement of drilling platform, where only one motor is mounted to drive rotary table and cathead.

flexible rig in sight

Sun Oil Company's new Ideco rig with Electro-Motive Diesel-Electric Drive takes the draw works off the drilling floor

Innovation in deep-well drilling rigs is the new unit built for Sun Oil Company by Ideco, one of the Dresser Industries, at its plant in Beaumont, Texas.

Powered by a pair of Electro-Motive SR-8 Diesel-Electric generator sets driving 7 motors, this revolutionary rig offers entirely new standards of flexibility, efficiency and economy.

Only one motor, powering the rotary table and cathead, is mounted on the platform. The Ideco 2500 series electric draw works is located beneath. This design avoids clutter, saves space and makes the rig easier and more economical to move.

Electro-Motive Drilling Rig Power Plants can be used with *any* drilling equipment operating today. The motors driving draw works, rotary table and mud pumps are connected by flexible cable to the generating units—and the connections can be made by anyone with a simple understanding of house lighting.

But to make doubly sure the equipment is properly used, we instruct your people both on the job and at our Factory Training Center in La Grange.

For further information about this moneysaving Diesel-Electric power, call your nearest Electro-Motive Representative.

Features of Electro-Motive Drilling Rig Power

Completely Integrated Design—Each of the major components designed and built to work together—*one* manufacturer—*one* source of service responsibility.

Maximum Portability—All components on skids with weight reduced to a minimum. Units are ruggedly built to withstand handling. No position problem—slashes setup and moving time on land rigs.

Unmatched Flexibility—At a flick of the selector switch on the driller's control panel, power can be selected from one or more generators to meet any power requirement.

Simplified Control—Centralized position of all controls for driller's convenience—continuously variable draw works speed control and complete rotary table torque control at the driller's finger tips.

Lower Drilling Costs—Lower first cost and lower cost per well drilled. Smooth electric power—flexible control—means less down time, speeds drilling.

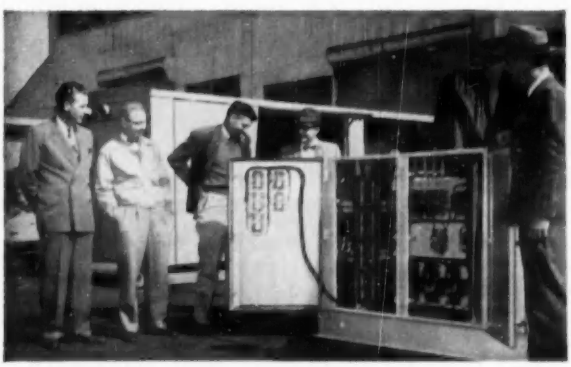
COMPLETE NATIONAL SERVICE AND PARTS AVAILABILITY

ELECTRO-MOTIVE DIVISION

GENERAL MOTORS • **La Grange, Illinois**

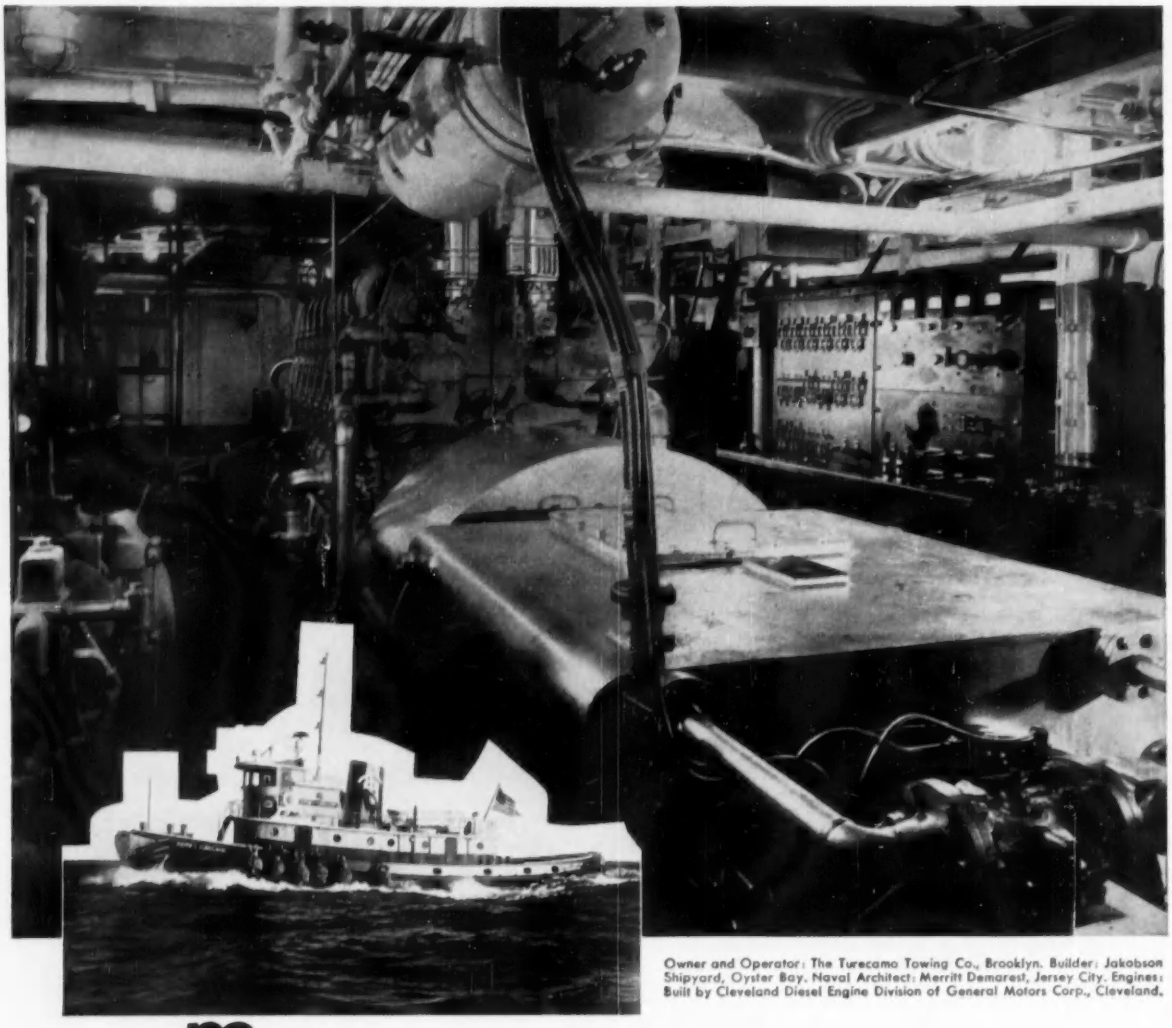
In Canada: GENERAL MOTORS DIESEL LIMITED, London, Ontario

Petroleum Industry Sales Offices: 1008 Philtower Building, Tulsa, Oklahoma, and 1222 Texas National Bank Building, Houston, Texas



Compact electrical control cabinet utilizes proved components of General Motors Diesel-Electric locomotives. In photo are W. O. Cook, Bert Hefner, Bill Withers, Sun Oil Company, "Buck" Wilder, Sun Oil Company, and A. R. McLerran, Ideco.

Driller's control stand is located on corner of the floor. Control panel carries selector switch, engine speed, mud pump, hoist and rotary table controls, as well as warning lights and safety switches.



Owner and Operator: The Turecamo Towing Co., Brooklyn. Builder: Jakobson Shipyard, Oyster Bay. Naval Architect: Merritt Demarest, Jersey City. Engines: Built by Cleveland Diesel Engine Division of General Motors Corp., Cleveland.

Marquette GOVERNORS provide steady power control for the new "Barney Turecamo"

Extreme accuracy is just as important as extra power on today's modern diesel tugboats. That's why Marquette Hydraulic Governors by Curtiss-Wright are specified for tugs like the "Barney Turecamo", one of the newest tugboats serving New York Harbor.

Thousands of diesel-powered marine vessels of every description are daily proving the accuracy and dependability of Marquette Governors. Our engineering facilities are at your disposal for solving all problems of power control.

Massey GOVERNORS

Marquette GOVERNORS

MARQUETTE METAL PRODUCTS DIVISION

CURTISS-WRIGHT

CORPORATION • CLEVELAND 10, OHIO

Other Marquette Products: AIRCRAFT WINDSHIELD WIPERS • ANTI-FRICTION BEARING TEXTILE SPINDLES • SPRING CLUTCHES PRECISION PARTS AND ASSEMBLIES • ROTARY OIL PUMPS

New York Central's 375 Alco diesels are equipped with Ni-Resist exhaust manifolds. (Upper right) Part of manifold used on NYC locomotives to eliminate costly, time-consuming "between-overhaul" maintenance on diesels.

Ni-Resist exhaust manifolds save work! Long life cuts "between-overhaul" maintenance

The New York Central System obtains 24 to 30 months' life and more from diesel engine exhaust manifolds of Ni-Resist* austenitic iron, alloyed with nickel and chromium.

This service matches the railroad's regular overhaul period.

New York Central thus eliminates between-overhaul maintenance of exhaust manifolds on some 375 Alco passenger, freight and road switch locomotives.

The road makes a big cut in maintenance labor and expense. But that isn't the whole story . . .

Ni-Resist manifolds minimize burnouts

Burnouts that disrupt schedules and cause expensive delays are reduced, because Ni-Resist manifolds retain ample strength at temperatures in the range of 1200°F. They give satisfactory service on turbocharged and supercharged diesel engines because...

Ni-Resist manifolds are heat resistant

They resist oxidation and scaling. The scale that does form is thin, tight and adherent. No "flake-off" to damage turbine blades. Use of Ni-Resist austenitic cast iron prevents warping and growth as well as cracking. The expansion rate of Type 3 Ni-Resist iron conforms with that of other parts in the engine system. So joints stay tight.

In certain other types of engines Type 2B Ni-Resist parts may be used for a different level of expansivity. Ni-Resist castings can save you money in other diesel engine applications, too. In cylinder liners, valve guides, and ring groove inserts for aluminum pistons. If you are having trouble with such parts, fill in the coupon . . . mail it now.

*Registered Trademark

The International Nickel Company, Inc.
67 Wall Street, New York 5, N. Y.
Gentlemen: We're having trouble with

☐ exhaust manifolds ☐ cylinder liners
☐ piston inserts ☐ valve guides
due to heat ☐ corrosion ☐ wear ☐

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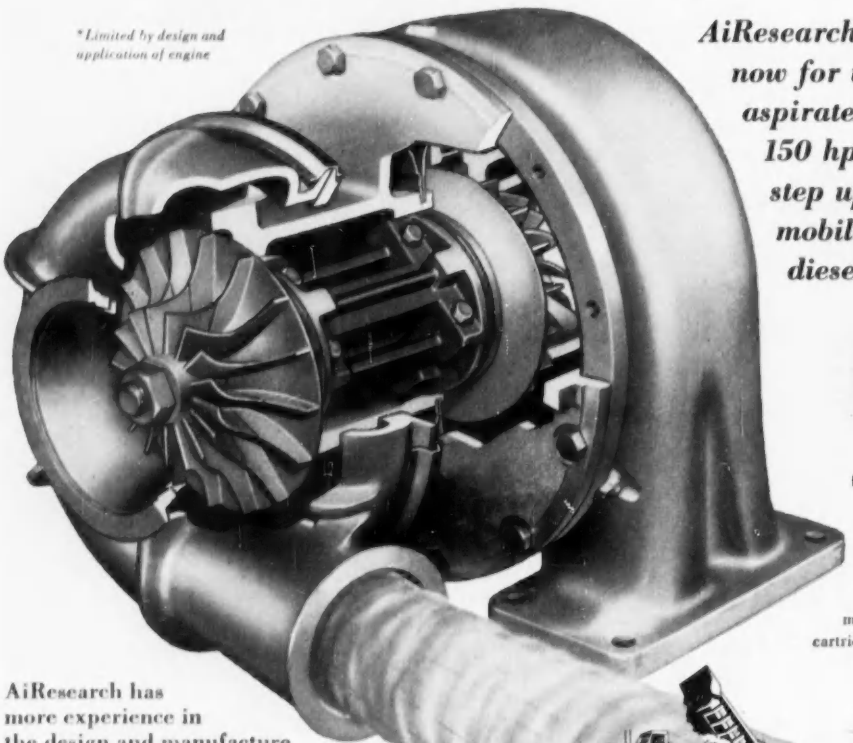
☐ Please send booklet, "Diesel Dan's Manual".

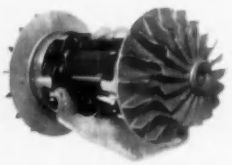
INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

AiResearch Turbochargers improve diesel engine performance up to 100%*

**Limited by design and application of engine*



AiResearch units are available now for use with normally aspirated diesel engines of 150 hp and up. They step up performance of both mobile and stationary diesels, land or marine.



Removable cartridge simplifies repair and overhaul

This cartridge contains the turbocharger's rotating assembly, bearings and seals in a factory balanced package. It can be replaced in minutes with another factory balanced cartridge by a mechanic on the scene.

AiResearch has more experience in the design and manufacture of small turbomachinery than any other company. AiResearch turbochargers are the most efficient and safest units of their kind. New additions to the AiResearch family of turbochargers have widened their range of application in the diesel engine industry.

Our engineers welcome the opportunity to work with you in improving the performance of your diesel engines. We are happy to confer on applications of the turbocharger principle to your power plants.

AIRESEARCH TURBOCHARGERS NOW AVAILABLE

MODEL	T-10	T-15	T-16	T-30
Diameter — in. nom.	9	15¼	11½	15¼
Length — in.	9	16¾	15¾	17¼
Weight — lb.	39	125	100	135
Output — lb/min. (Standard Conditions)	25-40	35-65	45-65	70-95

THE GARRETT CORPORATION

AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California

DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND RELATED MACHINERY

SIOUX SIOUX SIOUX

WISE BIRDS BUY THE TOOL, NOT THE DEAL—In these days of special price deals, special trade-in deals, and special credit deals, it may seem dull to speak of the wisdom of buying quality tools that last longer. • Are they all bargain hunters? Of course, they are! Do they know what a bargain is? You bet they do! A bargain is the finest, longest lasting piece of precision equipment you can lay your hands on. Price *is* important, but only in relation to quality. If this were not true, there wouldn't be more SIOUX Valve Face Grinding Machines in use than all others combined. If this were not true, the SIOUX reputation for long lasting quality electric tools wouldn't be worth so much. • In the fields we serve, it's gratifying to see that what you have to sell is still more important than what you will do to sell it.

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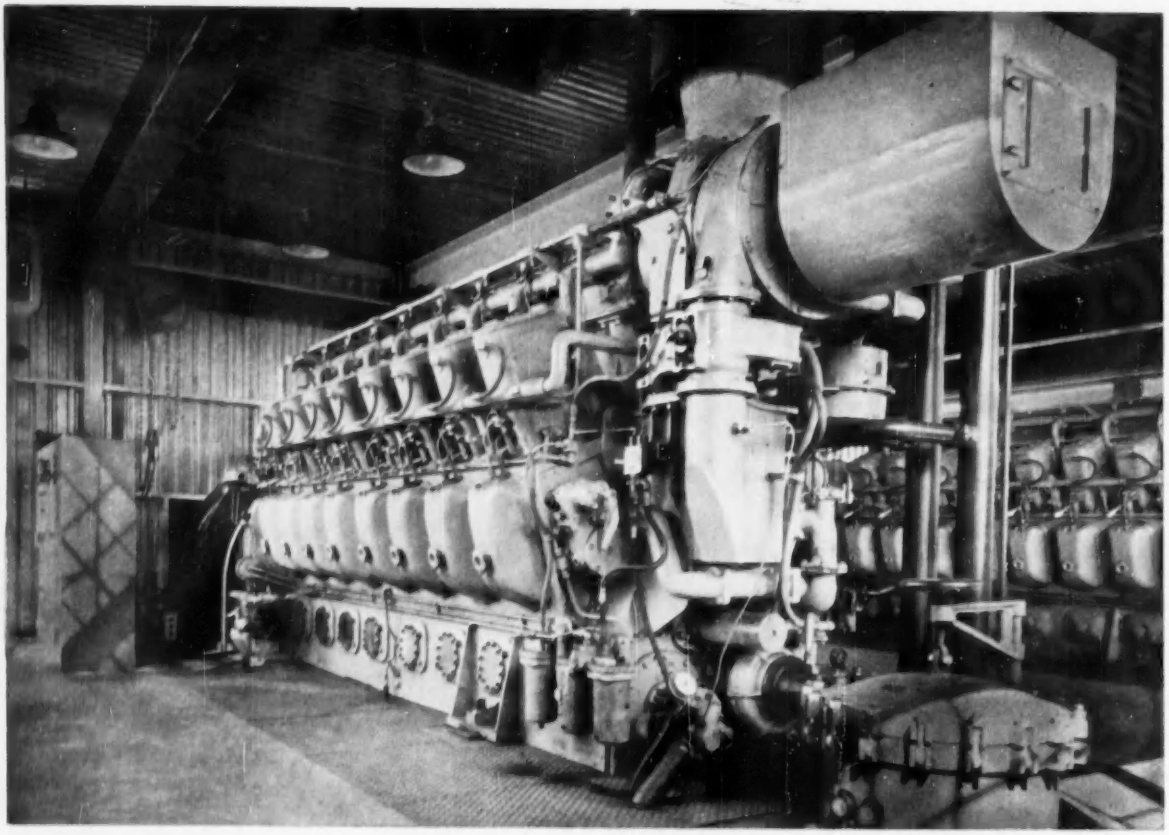
ELECTRIC DRILLS • SANDERS • GRINDERS • IMPACT WRENCHES • POLISHERS • PORTABLE SAWS • FLEXIBLE SHAFTS • VALVE FACE GRINDING MACHINES • ABRASIVE DISCS



ALCO 251 DIESEL SETS MODERN STANDARDS IN WEIGHT, POWER, ECONOMY

The ALCO 251 diesel brings modern standards of light weight, high power, high efficiency and increased economy to all stationary and marine applications. Ranging in horsepower from 550 to 2400, the 3 modern turbo-supercharged 251 diesels — in-line six, Vee 12, and Vee 16 — all have interchangeable working parts. With a wide selection of standard modifications available, the engines are ideally suited to applications where the following advantages are desired:

Low Initial Cost — Standardized design, produced on assembly-line basis.

Low Installation Cost — Lower weight per horsepower, compact design, four-point mounting, and adaptability to "packaged" power applications.

Low Operating Cost—Strong, rugged weldments, modern metallurgy, adaptability to remote or automatic operation, and readily available, low-cost replacement parts.

Complete Service Facilities — Seven regional warehouses, three repair and rebuild centers, experienced field-service engineering.

Contact your nearest ALCO sales office or write P. O. Box 1065, Schenectady 1, New York for information.

ALCO

ALCO PRODUCTS, INC.
NEW YORK
Sales Offices in Principal Cities

The Engineer's Field Report

CASE HISTORY
RPM Delo Oils
LUBRICANT
Progressive Transportation Co., Compton, California
FIRM

RPM DELO holds piston wear to .001" after 201,253 miles of on-and-off highway hauling

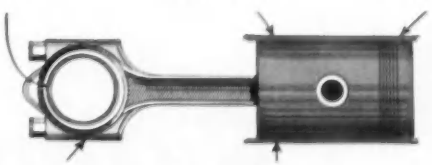
LUBRICATED WITH RPM DELO Oil, these engine parts were pulled from a Cummins HR diesel after 201,253 miles. A portion of this mileage was put on during four months of rugged service spotting loads of heavy pipe in the Arizona desert. When the engine was taken down, after two years of this on- and off-highway hauling, Progressive Transportation Co. found RPM DELO Oil had kept lacquer, gum, sludge, and deposits from forming...rod bearing wear varied between .0005 and .001 inch and pistons showed maximum wear of only .001". No wear at all evident on main bearings. Progressive Transportation uses RPM DELO Oils in all its large fleet of tractors—some of which have traveled well over 200,000 miles without overhaul.

Why RPM DELO Oils prolong engine life

Special compounds stop corrosion

Anti-oxidant resists lacquer formation

Detergent keeps all parts clean



Metal-adhesion qualities keep oil on parts in running or idle engines—inhibitor resists foaming

LUBRICATING OILS RPM DELO

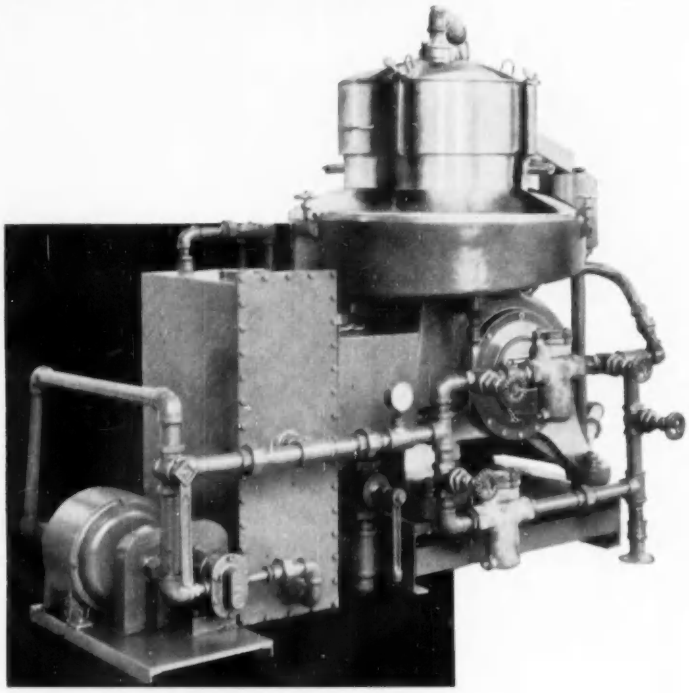
For More Information... about this or other petroleum products of any kind, or the name of your nearest distributor, write or call any of the companies below.

STANDARD OIL COMPANY OF CALIFORNIA, San Francisco 20 • **STANDARD OIL COMPANY OF TEXAS**, El Paso
THE CALIFORNIA OIL COMPANY, Perth Amboy, New Jersey • **THE CALIFORNIA COMPANY**, Denver 1, Colorado

Have You

CHECKED THE FACTS Lately about

BUNKER "C" AS A LOW COST DIESEL FUEL?



More and more diesels are showing *extra-low operating costs* because Sharples residual oil purifiers are making it possible to burn Bunker C satisfactorily.

Sharples has eliminated the bothersome headache of frequent bowl cleaning—and with a Sharples, the unburnables are removed continuously without extra labor.

Whether or not you've seriously thought of burning low cost residual oils before, you owe it to yourself to get the latest facts direct from Sharples. There is no obligation, of course.

SHARPLES

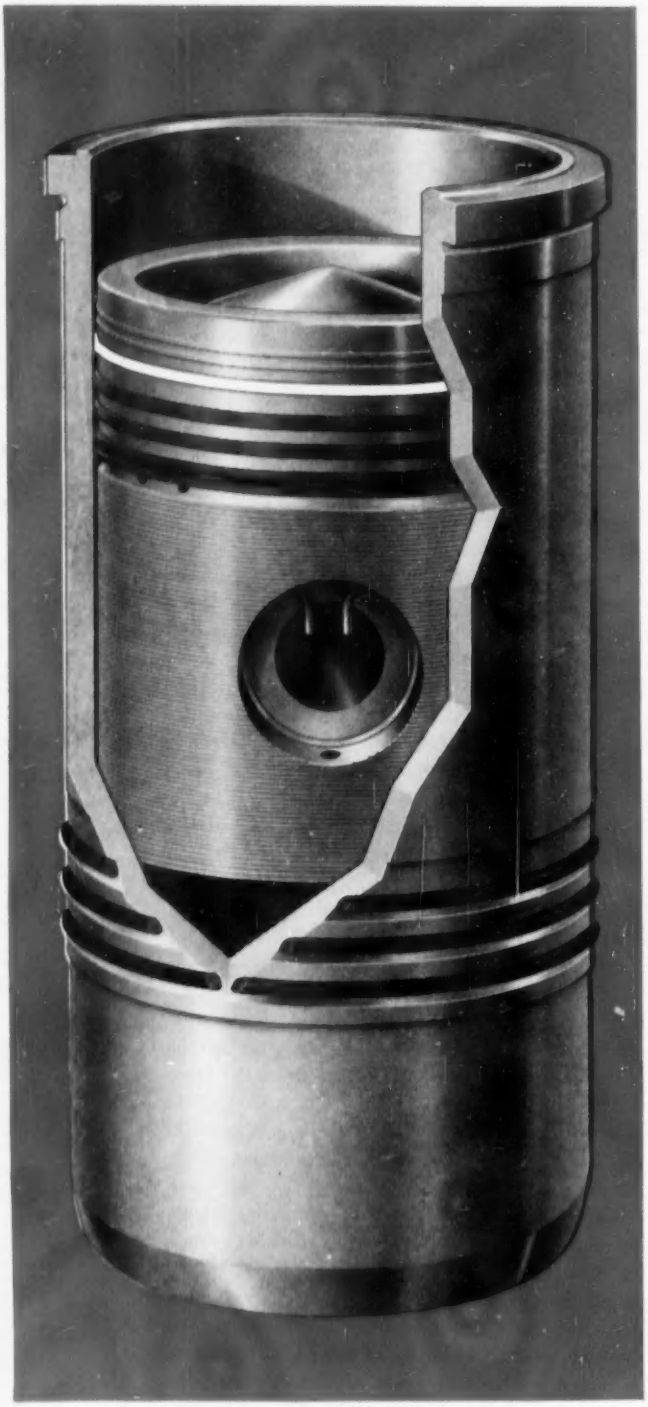
THE SHARPLES CORPORATION
2300 WESTMORELAND STREET • PHILADELPHIA 40, PENNSYLVANIA
NEW YORK • PITTSBURGH • CLEVELAND • DETROIT • CHICAGO • NEW ORLEANS • SEATTLE • LOS ANGELES • SAN FRANCISCO • HOUSTON
Associated Companies and Representatives throughout the World

editorially speaking

Impact of the Highway Bill

Fifty-billion is a lot of bucks. That's about what federal and state funds add up to under the terms of the Federal-Aid Highway Act of 1956. A good chunk of it will wind up in the diesel industry's pocket; modern roadbuilding is a diesel job all the way. The size of the program will mean a lot more equipment, and existing units will be working harder. Its long-term aspect will provide an element of stability making investments for new equipment attractive. Smart contractors will be taking advantage of the added power, high capacity, versatility and low operating costs of today's equipment. It will make a lot of difference in how sharp the pencil can be in preparing bids. So there are going to be a lot of new diesels sold. This also goes for major drive components—torque converters, fluid couplings, clutches, transmissions, etc.—that mean so much to today's high performance. Also, tighter and longer work schedules will mean increased parts sales and a higher volume of consumed products. Take a look at the survey presented in this issue about why people buy diesels. The prominence of "Factory Parts & Service Availability" as a motivation factor should be a tipoff to manufacturers. More units and harder, longer service will affect maintenance too. Deadlined equipment holding up production will make the maintenance department as popular as a mole in the front lawn. Now's the time to give your program a careful eyeing before a bigger work load puts a double-whammy on it. See if the setup is sound and streamlined enough to stand expansion. And what about the parts room? How's it doing anyway? Are you getting the right parts at the right time? With equipment working around the clock, how are you fixed for getting service and parts right on the job? Better start thinking about mobile repair crews and parts cribs. Fuel and lube handling too. We've just touched on some of the angles; we'll spell them out in a later issue. Just wanted to start you thinking about some of these things—now.

BPE



Sealed Power Diesel Sleeves

combine fine engineering with complete modern manufacturing facilities

Sealed Power is a leading supplier of cylinder sleeves for Diesel engines, both for original equipment and replacement use. Sealed Power's complete modern sleeve factory at Rochester, Indiana, is the only factory in the world devoted exclusively to cylinder sleeve production. Its heat treating and precision machining equipment are without equal.

As major engineers of sleeve design, Sealed Power's staff is in the unusual position of being concerned also with the design of piston rings and pistons. Inasmuch as sleeves, pistons and rings must all work together to produce top performance, engineering knowledge of all three is necessary for top quality in each.

Because of uniform excellence in all these products, Sealed Power Sleeve Assemblies have achieved an industry-wide reputation for superior performance in the field.

Whatever your sleeve requirements, whether in standard or hard sleeves, you will find it profitable to consider Sealed Power Diesel Sleeves. Your inquiry is invited.

SEALED POWER CORPORATION—MUSKEGON, MICHIGAN—ST. JOHNS, MICHIGAN—ROCHESTER, INDIANA
DETROIT OFFICE—7-236 GENERAL MOTORS BUILDING—PHONE TRINITY 1-3440

Sealed Power Piston Rings

PISTONS • CYLINDER SLEEVES

Leading Manufacturer of Automotive and Industrial Piston Rings Since 1911 • Largest Producers of Sealing Rings for Automatic Transmissions—Power Steering Units

highlights

For the rail fans . . . There's a restaurant called Hamburger Junction in Baltimore which makes use of a toy model B&O train to dispense food to the customers. Equipment isn't dieselized, but the food is good.

The first six months of this year saw 785 new locomotive units installed on Class I rails. All were diesel-electric. Total diesel-electric units for the same period last year was 590. On order for the last half-year segment are 769 diesel-electrics which is exactly 300 more than the same period in 1955.

An aggressive diesel-cycle engine program is currently being conducted by Army Ordnance. It calls for development of an air-cooled, multi-fuel engine for use in combat vehicles. Objective is to produce an engine that will use 35% to 40% less fuel than existing models, yet operate on various fuels without any change in performance. Promising pilot models are expected to be available for test soon.

The 100,000 steam locomotive lineup abroad is beginning to crack, (see News of Our Industry). Australia, for example, has discovered that diesels originally costing $175,000, are saving $90,000 per engine per year. And England which has stuck to steam because of its domestic coal supply, is undergoing major dieselization. This despite the fact that fuel has to be imported.

Waterflooding, a method of bringing up more oil by pumping water into producing wells, today accounts for 5% of the nation's crude oil. By 1980, the figure will jump to 25%. And early in the next century, 60% of our oil will come from such projects.

Keep Sept. 10 through 12 open. Those are the dates of the annual Locomotive Maintenance Officers' Assn. meeting in Chicago. And from a peek pre-convention diesel maintenance presentations, it looks like the affair is going to be better than ever this year.

The trend to mobility has caught up with utilities abroad too. Two 500-kw mobile diesel generator units have gone to Venezuela from White, for a government-owned power system that is being expanded. Orders for similar equipment have been received by the company from other Latin American nations.

Aluminum is figuring prominently in solving truckers' "dead load" problems, with diesel engines getting the treatment as well. As much as 135 lb has been saved by using aluminum fuel tanks, radiator shells, flywheel housings, oil cooler housings, water manifold castings, timing gear covers, and balance weight covers. One truck manufacturer says the engine could be reduced by as much as 400 lb if all aluminum engine parts marked as optional were used.

Why People Buy Diesels

Results of a survey in which engine users rate the factors influencing selection of diesels in order of importance. This is the first shot in a campaign started by Diesel Power to sound out users' opinions on various subjects. This report is basic and should prove helpful. There'll be more—Editor

WHY do people buy diesels in preference to other forms of power? Or one make of diesel versus another? What are the factors that they consider in each case? And what is the relative importance of each? Is motivation the same for purchase of medium and low-speed diesels as for high-speed types? And does it vary with different fields of end-uses?

These were the questions that we wanted answered in the first of a series of surveys initiated by DIESEL POWER and announced in an editorial in our April 15th issue. We have set up an "Industry Board" selected from among our readers. Each circulation category (*i.e.*—Engine and Equipment Distributors, Diesel Service and Repair Shops, Municipal and Utility Personnel, etc.) is represented percentagewise. Also, the fields of high-speed, medium and low-speed engine usage are represented roughly in proportion to the number of each type unit in use.

A total of 325 men from our industry comprise the board and their opinions were carefully tabulated. The charts tell the story but perhaps some interpretation would be helpful. Also, comments, additional to the prepared questions, were solicited. Many of these will be of interest.

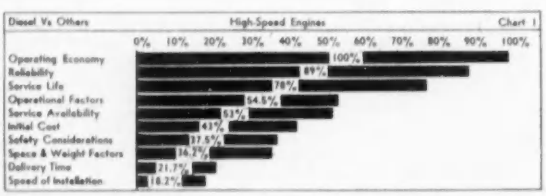
The questionnaire really put the Board to work. They were asked to identify their answers as applying to engine sizes and types as well as to the end-use categories. Then they were asked to rate certain factors in order of importance as they applied to the selection of the diesel (1) in relation to other forms of power and (2) between one make and another.

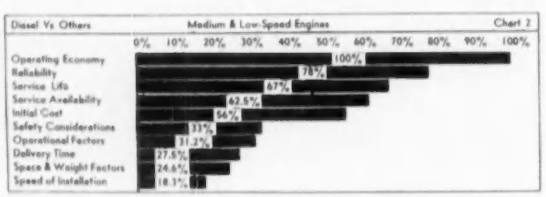
Factors in the first category are shown in Charts Nos. 1, 2 and 3; those in the second category, in Charts Nos. 4, 5 and 6. To see if there was any difference in motivation factors with respect to engine size, returns were tabulated separately under "high-speed", "medium and low-speed", and a "both" category representative of the thinking of board members concerned with all types.

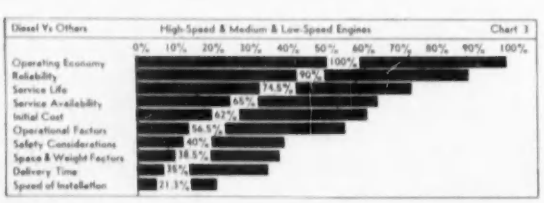
After tabulating the charts in the second category, the first three preferences selected were correlated with the field of usage. This was done to see how the three major preferences (there was no question that these were valid across the board) stacked up in different end-uses.

In the "Diesel vs Other Forms of Power" category, ten items were listed, these being factors that, being on the plus side, would influence the purchase of the diesel. "Operational Factors" is the only one that is not immediately self-explanatory. It refers to torque, rpm, useable speed range, over-load capacity, smoothness of operation, simplicity of operation, etc.

In the second category, 14 items were listed. "Configuration" refers to whether the engine is a vee-type, in-line, opposed-piston, etc. The objective was to see if there was any strong feeling on the subject. "Desire for Uniformity" applies where a new engine is being integrated with presently-owned engines. The idea was to find the relative importance of possible savings in parts stocking and keeping uniformity of maintenance techniques.







Regarding "Factory Service & Parts" both "Availability" and "Policy" were explored. The former is self-explanatory and the latter refers to such matters as the parts pricing and discount structures, attitude on warranties, provision of service information, etc.

One more thing and we'll be through with the mechanics of the job. As you might expect, there was considerable divergence in individual opinions. Tabulation showed that most items, while receiving a preponderance of votes as, say for example, third choice, would also receive substantial numbers under other priorities. Priorities were assigned weights in descending order and thus weighted averages could be computed and each selection made to count. Correlation with the priority under which each item received the top number of votes was excellent.

To give an idea of the relative importance placed on each item, the weighted value of the first choice was considered 100% and the values of other choices were computed as percentages of the first choice value. This is indicated in the charts.

You'll note that Chart No. 7 rates the first three preferences in somewhat different order than do Charts Nos. 4 through 6. There are two reasons. This was a straight numerical computation that disregarded all votes not rating the factors as first, second or third choice. Secondly, these votes were tabulated on the basis of end-use rather than on type of engine.

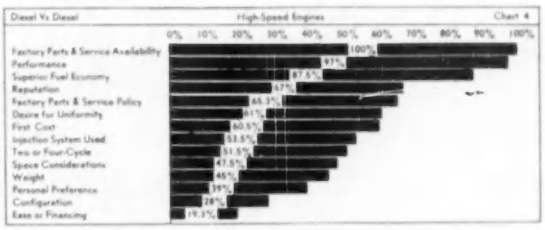
We don't know whether the survey will confirm your ideas or whether it contains some surprises. It certainly confirmed our thinking that the matter of parts and service were of major importance to the field and hence indicated the editorial area in which we could render the greatest service.

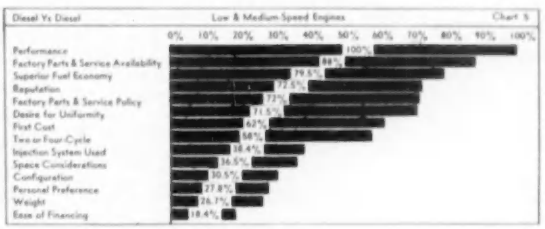
There were some surprises too. Picking one, from a quick check of early returns we felt that "Ease of Financing" was going to be a major factor. It dropped to last place when the totals were in.

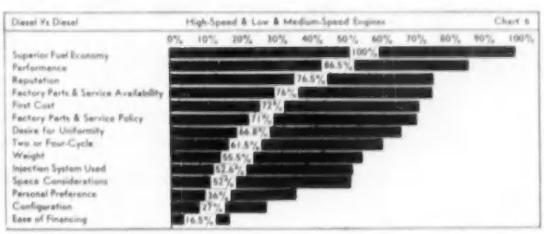
Now for some of the comments. These are the spice of a routine tabulation diet. A good many board members pointed out the difficulty in evaluating the factors without a specific application in mind. As one put it, "For logging operation, rugged construction for rough handling comes first; for stationary use, quick availability for standby service." We realized this flaw from the start; it is basic to most statistical studies. Although valid enough as a guide, they are always subject to individual interpretation.

There was one added starter in the "make vs make" category and we blush to think that we left it out. It is "Ease of Maintenance" and enough write-in's were noted to convince us that this would be a major motivation factor. In any case it is something for the engine builders to keep in mind.

Builders of injection equipment should prick up their ears too. Several returns qualified the emphasis placed on the "Injection System Used" factor, explaining that their major interest was the comparative cost of repair among different makes.





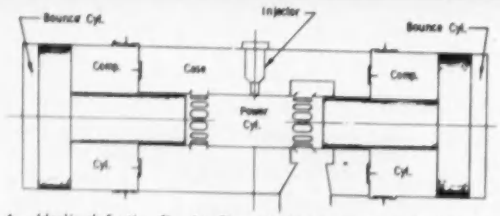


Preference Priority Vs End-Use .. Chart 7

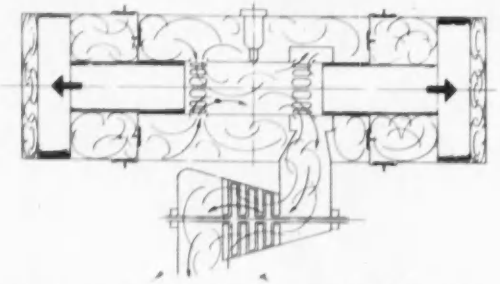
Preferences Nos. 1, 2 & 3 Correlated With End-Use	Performance	Factory Parts & Service Availability	Superior Fuel Economy
Railroads	1	3	2
Trucks	1	2	3
Buses	1	3	2
Marine	1	2	3
Petroleum	1	3	2
Agriculture	1	2	3
Mining	1	3	2
Municipal & Utility	2	3	1
Logging	1	3	2
Quarrying	1	2	3
Construction	1	2	3
General Industry	1	2	3

Another item that kept popping up in the write-ins was the engine's adaptability to burn different fuels. In the high-speed field it concerned whether No. 1D or 2D was needed for good performance. In the larger sizes, ability to burn the heavier fuels, including No. 6, was thought important.

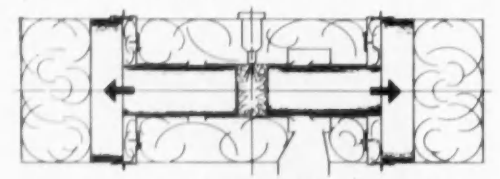
(Continued on Page 75)



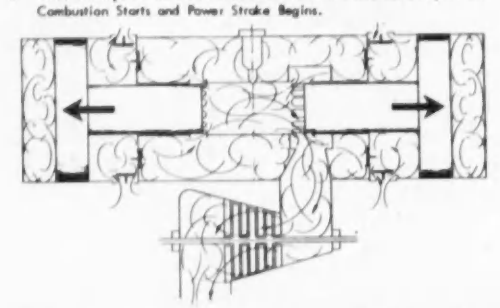
A - Idealized Section Showing Pistons in Starting Position. Intake and Exhaust Ports Open. All Valves Closed.



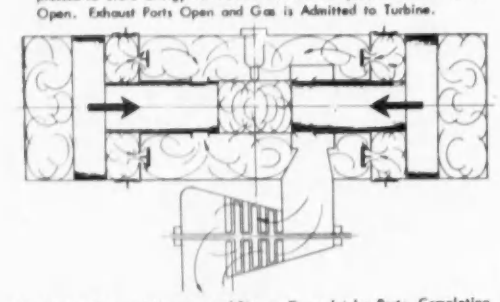
B - Starting Air Pressure Admitted to Bounce Cylinders. Pistons Move Inward, Closing Ports, Compressing Air in Power Cylinder, and Forcing Scavenging Air From Compressor Cylinder Into Case.



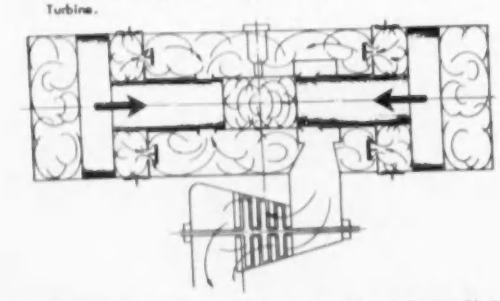
C - Pistons Complete Inward Travel. Fuel is Injected Into Power Cylinder. Combustion Starts and Power Stroke Begins.



D - Pistons continue outward Travel. Air in Bounce Cylinders is Compressed to Store Energy for Return Stroke. Compressor Intake Valves Open. Exhaust Ports Open and Gas is Admitted to Turbine.



E - Further Outward Movement of Pistons Opens Intake Ports, Completing Power Stroke. Case Air Scavenges Power Cylinder and Escapes to Turbine.



F - Pressure in Bounce Cylinder Moves Pistons Inward Starting Next Cycle.

Free-Piston Engine Powers Car

Combining some features of the diesel with the gas turbine, GM's GMR4-4 "Hyprex" free-piston engine-gas turbine unit is undergoing evaluation testing. Preliminary results indicate performance and economy comparable to other types of automotive engines while having advantages of its own.

LOOK under the hood of General Motor's newest experimental automobile, the XP-500, and you'll find a siamesed free-piston engine or gasifier. At the rear axle you'll find a gas turbine. This marriage of the diesel cycle with the gas turbine was developed and built by GM to test the potentialities of small free-piston engine-gas turbine combinations.

Many of its characteristics looked so promising for vehicular application that it was installed in a specially-designed experimental car for evaluation. These advantages, however, do not limit this power unit concept to vehicular application; there are a good many others to consider.

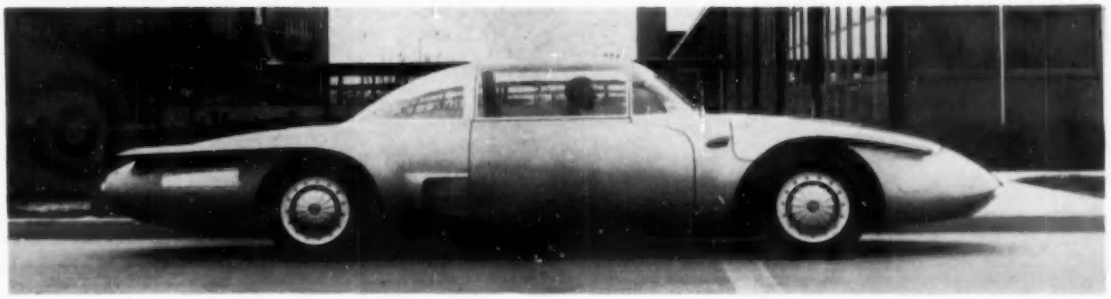
The power unit of the XP-500 was built around the concept of a small, light-weight prime mover of 250 hp. It has good thermal efficiency, smoothness of operation, excellent torque characteristics and a very favorable power-to-weight ratio. These and other characteristics will be discussed.

First, How Free-Piston Engines Work

Start with the picture of a turbocharged diesel in mind. Here, at the end of the power stroke, enough energy remains in the exhaust gases to turn the turbocharger expander wheel and compress scavenging air. However, most of the combustion gas energy is used to turn the crankshaft and produce power.

Now suppose that we take a 2-cycle, uniflow, opposed-piston engine, remove the connecting rods and crankshaft and arrange the engine so that the pistons only compress the scavenging air. It will also be necessary to compress air in "bounce" chambers but as in the case of a flywheel, the energy absorbed is fed back into the cycle on the compression stroke.

With such a setup, only a small portion of the combustion gas energy is used by the pistons and consequently a large portion goes out the exhaust. You use a larger turbine to make use of this energy and produce the power



output. So you can see that the free-piston engine-gas turbine combination could be considered an extention of the idea of turbocharging; it's only a matter of how you use the heat energy in the fuel and from what device you take the power.

The sequence of operation of the GM unit is illustrated. It is fairly typical of gasifiers using "inward" scavenging air compression. More on this subject later. Pistons are maintained in proper relationship to each other by a simple parallelogram linkage.

Gas horsepower output to the turbine varies basically with the speed of the reciprocating cycle and the length of the pistons' strokes. Cycle speed depends on the mass of the parts and the spring effect in the bounce chambers. It can be seen that the length of stroke will be varied by control of the fuel injected or change in bounce chamber pressure.

Why Free-Piston Engines?

Engineers would be remiss if they were not trying constantly to produce power more simply and efficiently. Rotating machinery such as the conventional gas turbine is an attractive possibility. However, from an engineering viewpoint the simplicity is deceptive; from a metallurgical viewpoint, operating temperatures necessary to obtain competitive thermal efficiencies are the headache. Progress is being made—but slowly.

Replacement of the compressor and combustor with a free-piston gasifier is a compromise between all-rotating or all-reciprocating machinery, but potentially a rewarding one. Mechanically, the free-piston unit has fewer parts than conventional engines, has a more favorable power-to-weight ratio and is a more simple structure.

Operationally, it has inherent smoothness and rapid throttle response. Reciprocating parts are balanced in weight and there are no exciting forces to cause vibration or torsional movement. Acceleration and deceleration are rapid since there is much less inertia involved than is found in crankshaft-type engines.

Thermal efficiency of the unit is high since the compression ratio, while variable, is generally higher than for diesel engines. The high weight of air trapped in the cylinder and the variable stroke produces compression ratios in the order of 30 to 1 up to 50-to 1 in the GM gasifier's normal operating range. GM quotes thermal efficiencies up to 40-45% at full load.

However, turbine efficiencies must be taken into account. These run in the order of 80%. So the combined efficiency of the power package is about 32-36%-high enough to be very competitive.

Regarding operating temperatures, the free-piston engine has a big edge over combustor-type units. GM pegs their inlet temperatures to the turbine in the range of 450 to 900°F. This means increased turbine life even with use of non-critical materials.

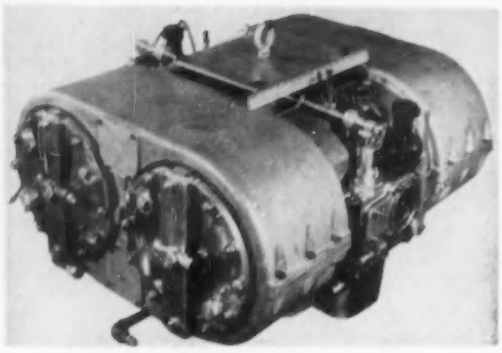
The difference between these temperatures and those from combustors lies in the fact that the power energy for air compression has been extracted from the gases *before* they reach the turbine in the case of the free-piston unit. In combustor types, gas energy must be supplied to the turbine for air compression as well as for power output.

Turbine inlet temperatures with the gasifier are so low in relation to conventional gas turbine temperatures that even with commonly-available turbine blading material, an afterburner could be used. Excess air containing up to 80% of the original oxygen content is available for combustion. Moderate power boost could be used continuously or high power surges for short duration could be made available to meet peak load conditions without excessive turbine blade temperature.

Another advantage of the free-piston engine-gas turbine for vehicular application is the ability to separate the units, placing the engine under the hood, and easily pipe the relatively low-temperature gases to the turbine at the rear. The drive line is eliminated. A characteristic common to all gas turbines is also desirable in vehicular applications. The stall characteristics of gas turbines produce high low-speed torques, so necessary for good performance.

These engines have demonstrated a broad appetite for different fuels. Used for many years in Europe, they appear to show less sensitivity to fuels than diesels of comparable bore size. GM's testing has shown successful operation in the range of petroleum products from 100-octane gasoline to crude oil. The engine has also been run on animal and vegetable oils but long-range effects on the engine were not evaluated.

Gas horsepower output is proportional to the heating value of the fuel used. So it would appear that the free-piston engine offers the option of using the most economic fuel in any given area.



GM's Siamesed Gasifier

By using two complete cylinder assemblies with a common base and common intake air and exhaust systems, GM has produced a unique and compact free-piston unit. Cylinders have a 4-in bore with 11-in diameter air compressor chambers. Nominal stroke is 5-in and a maximum stroke-per-minute cyclic speed was set at 2400. The whole works makes a package about 40-in long, 34-in wide and 18-in high.

While the engine design was based on a nominal 250 gas horsepower, the high-torque characteristics of the turbine at its lower speeds will provide about the same vehicular performance as a 300-hp conventional engine. The present gas turbine is a 5-stage, axial-flow unit.

In the test car it functions through a reduction unit with an approximate 7 to 1 ratio. The turbine's torque multiplication characteristics are such that it is believed a simple 2-step transmission will match the performance of current transmissions.

In this free-piston engine, scavenging air compression is "inward". While outward compression is considered slightly more efficient overall, it makes for a longer unit while somewhat complicating the structure, as well as inspection procedures. Also, external piping is needed to conduct air from compressor to intake port area.

GM's siamesed unit overcomes the efficiency loss associated with inward compression. Reason for this loss is that air compression occurs during the cylinder's compression stroke when the intake ports are closed. On outward air compression the reverse is true and thus pumping losses are reduced.

However, in the siamesed unit, the two sets of pistons are phased to be on opposite strokes. Since there is a common air box, air being pumped by one pair of pistons can enter the intake ports being uncovered by the other set. This reduces the overall pumping losses.

Dephasing the two cylinders is necessary for successful siamesed operation. It is handled by a pneumatic device sensitive to bounce chamber pressures. It acts to accelerate or slow the cyclic speed of one set of pistons until they are 180-deg out of phase with the other set. They operate parallel during starting and are forced out of phase within a few strokes.

As stated earlier, gas horsepower output depends on cyclic speed and piston stroke. These are controlled by the amount of fuel injected and the pressures in the bounce chambers. Fuel injection pumps of a conventional type are used and so variation in fuel quantities is no problem. Acceleration of the pistons from inner dead center is so rapid (due to low inertia) that the rate of delivery must be very fast. Pumps are cam-operated from the parallelogram linkage.

Bounce chamber pressures are under control of a device GM calls a stabilizer. It is a 2-way air valve between the bounce chambers and the air box. In each cycle, air box pressure will exceed bounce chamber pressure at some particular time and vice versa. The stabilizer permits air to flow to the bounce chambers for higher frequency operation and releases it to the air box for slower engine speed.

The simple free-piston configuration illustrated has trouble producing less than 25% of full power. A common practice to reduce this power level and one that gives very poor part-load efficiency is vent some exhaust gases ahead of the turbine. GM uses the method of "recirculation" to overcome this.

At low loads, part of the air-box air is bypassed back to compressor suction. The effect is to heat the incoming air, allowing combustion at lower compression ratios (reduced stroke). With the shorter stroke and lower engine speed, less air is pumped and fuel consumption is reduced. The result is to lower the gas output to the turbine without resort to dumping some gas.

In Conclusion

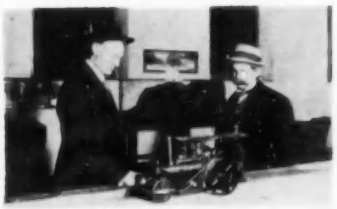
GM points out that this is a prototype engine built for purposes of evaluation. Even the chassis of the XP-500 was specially designed to utilize its advantages. The car also gives opportunity to evaluate advanced suspension, steering and rear-wheel drive concepts.

Principal conclusion from the testing to date is that a siamesed unit can be built with a power-to-weight ratio suitable for vehicular application. In addition, thermal efficiency of the unit is comparable with other types of automotive engines. Further improvement can be expected as design refinement takes place.

Such features as the stabilizer, dephaser and provision for recirculation, have improved performance and general flexibility of operation. The latter two features in conjunction with air system design have held air intake noise level satisfactorily low. As with turbochargers, the turbine smooths out power cylinder pulsation. No muffler is needed after the turbine.

In other applications, greater flexibility of horsepower output is possible by using the "building block" technique. Standard components could be used in a single cylinder unit; siamesed for higher output; or a number of siamesed units used to supply an appropriately-sized turbine.

So while the concept of the free-piston engine is over 30-years old, here we have a brand new version that will bear some watching.



First Roadshow in 1909 (left) featured mustaches, 40 exhibitors, and mostly steam-powered machinery. However the gasoline engine and the track had already been used successfully. 1930 (center) saw heavy machinery, still mostly on wheels. 1940 (right) produced a show that had machinery modern in design. 1948 (bottom) incorporated post-war designs, modern and well-tested by the war.

ARBA Holds "Roadshow"

Passage of the Federal-Aid Highway Bill provides background for a very important showing of the latest in construction machinery and equipment.

AMERICAN Road Builders' Association will hold its 1957 "Road Show" in Chicago. Since the first show in 1904, these shows have demonstrated both the trends in highway construction and the machinery to do it. The '57 show will be the biggest and most important show in the history of ARBA. Its timing is perfect.

Congress has just passed the Federal-Aid highway Act, providing $32.5 billion in federal funds for road-building. Matched by state money, it will spark a $50 billion construction program.

About $25 billion of the federal funds will be for the interstate road system. This money is to be spent over a 13-yr period at an average rate of about $2 billion per year. The importance of this aspect will be discussed later. An additional $2.55 billion will be earmarked to primary, secondary and urban road construction over the next three years. In all, there is a great deal of dirt to be moved, and a lot of new equipment needed to move it. That is where the Road Show comes in.

Manufacturers big and small will be laying on the line exactly what they have to offer. With the exception of some smaller units, it is going to be diesel all the way. Don't be surprised if a great many are available in turbocharged versions.

Roadbuilding equipment has followed a well-defined trend. It has been consistantly toward more powerful, faster and higher capacity equipment. The Federal-Aid Highway Act indicates that for some time to come these diesel-driven machines will be moving more dirt, for longer periods of continuous operation than ever before. The implications of this accelerated operation will be far reaching to the entire industry.

First, a great many new diesel-powered units will be bought. Then, increased utilization will mean more maintenance. This calls for additional, trained service personnel.

Then comes the question of parts, accessories and consumable items. All of these materials are going to be used in greater quantities and provision for supply, procurement, handling and storage must expand. And the provisions of the Highway Bill add long-range stability to the picture.

The 13-yr spread of the construction program allows the contractor to figure his machinery investment over the long term. And as construction is a competitive business, it is going to be the one who does the job fastest at lowest cost who gets the lion's share.

It is accepted that present highways are inadequate, if not obsolete. Enthusiasm to build better ones has been accentuated by the recent announcement from the White House. Construction volume is expected to increase an additional 24% this year alone.

This high activity level, plus the increasing role of good equipment in competative roadbuilding promises to make the 1957 Road Show a very important event, as well as something worth just seeing.

Baldwin-Lima-Hamilton Mec-Hydro locomotive recently delivered to New York Central railroad. This unit weighs about 87 tons, is 58-ft 9-in long, 11-ft high, and develops a top speed of 120-mph.

Diesel-Hydraulic Locomotive Hauls NYC "Xplorer"

Baldwin Maybach truck mounted diesel and mechanical hydraulic transmission powers new locomotive designed for light-weight, high-speed train.

AN entirely new type of locomotive has been introduced by Baldwin-Lima-Hamilton. This Mec-Hydro locomotive unit using a Baldwin Mayback truck—mounted diesel and mechanical hydraulic transmission was recently delivered to the New York Central System. Two similar locomotives units are scheduled for delivery shortly to the New Haven Railroad.

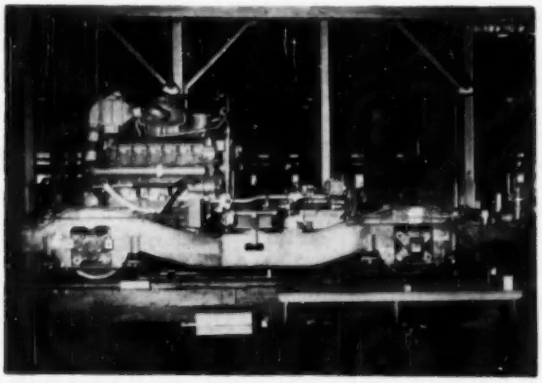
This light-weight locomotive was specifically designed for powering new light-weight, high-speed passenger trains, of which there are several types. (See DIESEL POWER, Sept. 1955 and Jan. 1956.)

The Mec-Hydro locomotive has one 4-wheel propulsion power truck under the front end and one 4-wheel idler truck under the rear end. The propulsion truck is a complete power package, having mounted on it the diesel engine, mechanical-hydraulic transmission, drive shaft and axle drives.

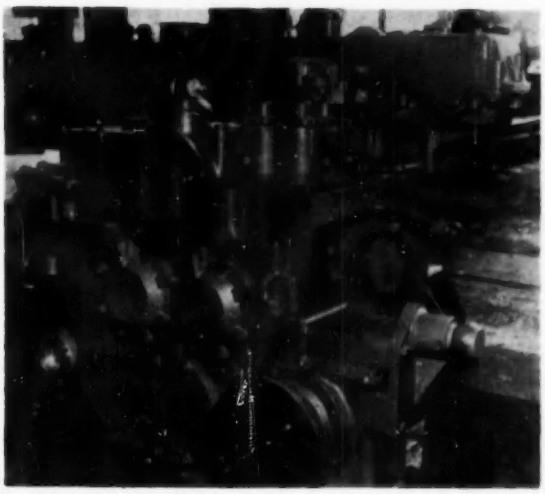
The locomotive body is suspended on the truck by means of body swing links. These permit the locomotive to roll toward the direction of lateral forces, thus reducing the effect of centrifugal force and allowing the locomotive to operate at higher speeds. The propulsion power unit is arranged so it can be replaced easily and quickly, thus providing for maximum utilization of the locomotive.

The weight of the unit delivered to NYC is reported to be approximately 87 tons. A conventional diesel-electric passenger locomotive unit weighs 125 tons and higher. Overall length of the new unit is 58 ft - 9 in, width 10 ft - 6 in, and its height has been reduced from the normal 15 ft to 11 ft to match the contour of the light-weight cars. The locomotive will develop a top speed of 120 mph. Tractive effort continuous rating is 21,000 lb at 12.6 mph.

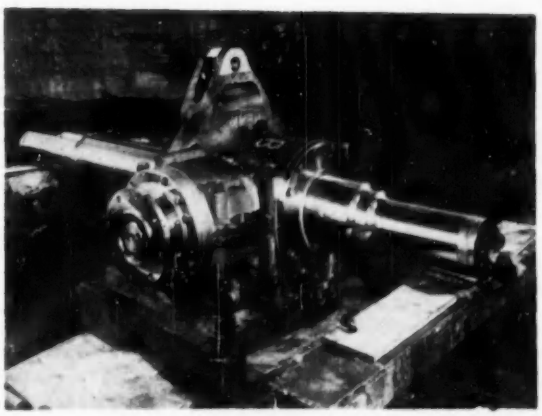
On both NYC and N-H railroads the Mec-Hydro locomotive units will haul the long-talked-about experimental Train "X", designed and built by Pullman-Standard Car Mfg. Co. One such 9-car train, named the "Xplorer", was delivered to the Central about the same time as the B-L-H-Mec-Hydro locomotives. This train is scheduled for operation between Cincinnati and Cleveland, Ohio, (260 miles).



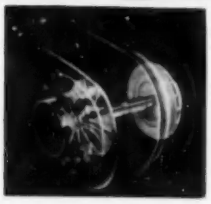
Propulsion truck is a complete power package, having mounted on it the diesel engine, mechanical-hydraulic transmission, drive shaft and axle drives. This 4-wheel power truck is mounted under the front end of the locomotive. The Mayback, engine is a vee-type, 12-cyl, turbocharged diesel rated 1000-hp at 1500-rpm.

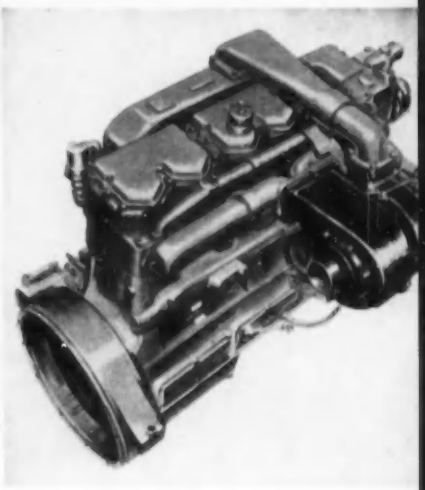


The Maybach Mekydro transmission consists mainly of a hydraulic torque converter; a 4-speed forward gear mechanism with four reverse speeds — including Mayback's over-running clutch with interlocking claws; and a control mechanism. All of these are housed in a single, compact, oil-tight cast iron casing.



Power from the diesel engine and transmission is delivered to the wheels of the locomotive through Baldwin's own design of axle drive units, one on each of the two driving axles.





Cummins Turbo for "Turbodiesel"

NEWEST of the "Turbodiesels" features a turbocharger manufactured by Cummins. This exhaust-turbine driven blower, in conjunction with the Cummins PT injection system, gives the engine very good torque characteristics and a favorable weight-power ratio.

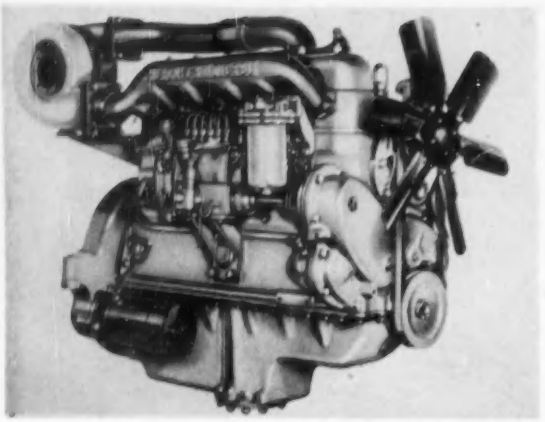
Designated NRTO-6, it develops its 335-hp at 2100-rpm. This rating is based on a 90°F. intake air temperature, from zero altitude to 4000-ft. Engine is derated 1½% for every additional thousand.

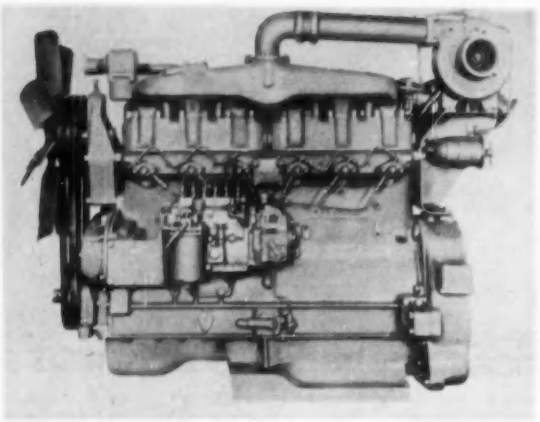
This Turbodiesel was designed by Cummins to meet the requirements for increased power without imposing the penalties of increased size and weight. Whether they succeeded or not can be determined by examining the data.

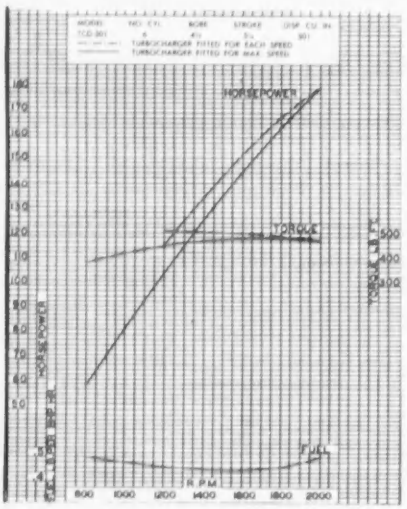
NH-600, the naturally aspirated version, weighs 2460-lb. It develops 200-hp, giving a ratio of 12.3-lb/hp. NHRS-600 (supercharged) weighs 2786-lb. This engine produces 300-hp, with a ratio of 9.3-lb/hp. The Turbodiesel is by far the best. It weighs only 2546-lb and develops 335-hp. This gives a ratio of only 7.6-lb/hp.

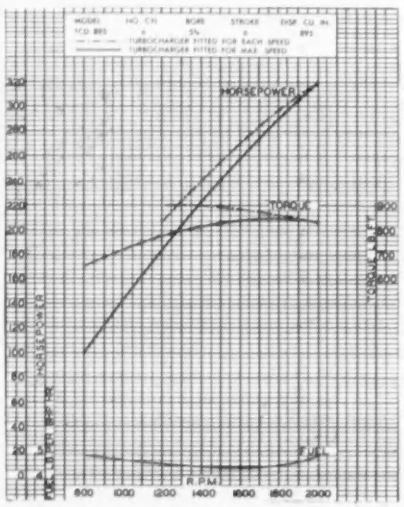
Compared to the naturally aspirated engine of the same displacement (743-cu in), NRTO-6 develops 67% more power. It produces 11½% more power than the mechanically-supercharged version. As would be expected, specific fuel consumption is considerably less with the turbocharger.

To facilitate installation in areas of limited space, T-590 turbochargers can be mounted on the NRTO-6 engine in three separate ways. Depending on the application requirements of the power user, mounting is possible on the rear, top, or side. This engine is available for marine use as well as in industrial versions.









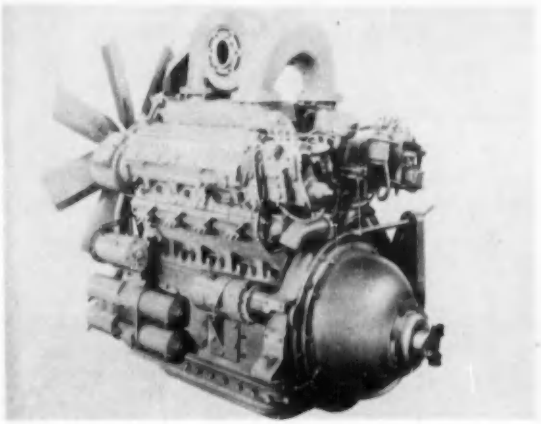
Turbocharged Models Added by Hercules

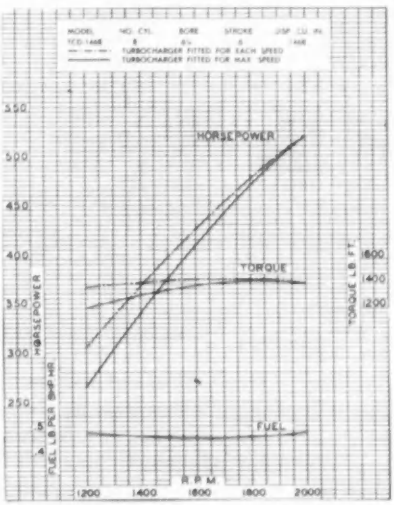
THREE new high-speed, turbocharged diesels are now available. These service-tested units have been introduced by Hercules as their new TCD series. Since 1950 they have successfully served their apprenticeship in many applications including busses, generator sets, mine cars, marine applications and other specialized equipment where compact power is essential.

An example of what these engines can do is shown by the case histories of two of these 6-cyl TCD's used in an 80-ton diesel-electric yard locomotive since March 1953. During this 39-month period they have operated 24-hr a day, seven days a week, for a total of 24,242-hr each. They had only one overhaul after about 14,000-hr. Otherwise these TCD's received only normal preventive maintenance. This typical performance of these engines earned them a reputation for reliability and trouble-free operation.

The first of the new series is the TCD-501, a 6-cyl engine having a 4½-in bore and 5¼-in stroke. This model, rated 178-hp at 2000-rpm has a 501-cu in piston displacement and a fan-to-flywheel length of 48 9/16-in while weighing about 2000-lb. Torque developed is about 485-lb ft at 2000-rpm. An important feature of this model is that the turbocharger may be positioned to fit the particular application. Various makes of turbochargers are available for each TCD model engine. Hercules engineers recommend the specific type to match the particular application.

The second of the turbocharged series is the TCD-895. This also is a 6-cyl engine, but with a bore and stroke of 5⅝-in by 6-in. Developing 320-hp at 2000-rpm, this model has an 895-in piston displacement. Having a fan-to-flywheel length of 62-in, the engine weighs about 3000-lb. The turbocharger on this model can also be positioned



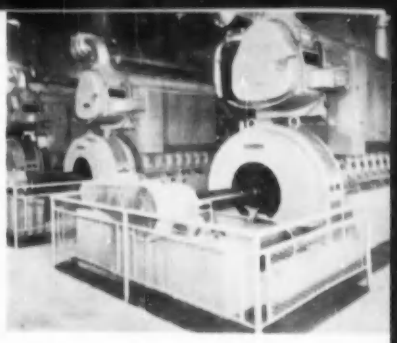


From left to right are shown Hercules' new turbo-charged diesels, Models TCD-501, 895 and 1468. Graphs give data on horsepower ratings at various speeds, torque, and specific fuel consumption.

to fit any application. The torque developed is close to 835-lb ft at 2000-rpm.

An 8-cyl, 45 deg, vee-type engine rated 520-hp at 2000-rpm is the third in the new series. This model TCD-1468 has a bore of 6¼-in and a stroke of 6-in. With a cu-in piston displacement of 1468 it develops a torque of about 1375-lb ft. Its fan-to-flywheel length is 59 7/16-in while weighing about 5100-lb.

In all of above models the sleeves are of the removable dry type made of special alloy. The TCD-501 has all six cylinder heads in one casting, whereas the TCD-895 and TCD-1468 have three and four-head castings respectfully. All pistons are of heat treated aluminum alloy with full-floating type piston pins. Crankshafts are of special steel with induction hardened bearing surfaces. Connecting rods are made of heat treated nickel chrome molybdenum steel, rifle drilled. Crankcases for the TCD's 501 and 895 are integral with the block while that of the TCD 1468 is split above center line of crankshaft.



Diesel Engines Stabilize Power for Missile Research

DIESEL engines are helping to remove crews from air combat operations. The "Battle of Research" needs the best minds, techniques and equipment available, and diesels are supplying stable power needed in this phase of our guided missile program.

Virtually every guided missile developed in this country goes to top-secret Air Force Missile Test Center, Cape Canaveral, Fla. for final testing. No one goes in or out without special screening and without an escort. The Base is constructed far out among the sand dunes of Florida's east-central coast.

As important as the program is, secrecy created a problem. Its remote location placed it 75-mi from the nearest generating station, creating a serious voltage and frequency problem. When power arrives at the Cocoa Station, 14-mi away, voltage has dropped from 66,000-v to 33,000-v. It is then sent to Cocoa Beach substation, where it is further reduced to 13,200-v before reaching the center.

Air Force officials found this power suitable for everyday base operations; but unsatisfactory for supersensitive tracking instruments. Voltage and frequency deviations of more than .001% played havoc with accuracy. It was decided to construct a base power plant, both to stabilize current and for emergency stand-by.

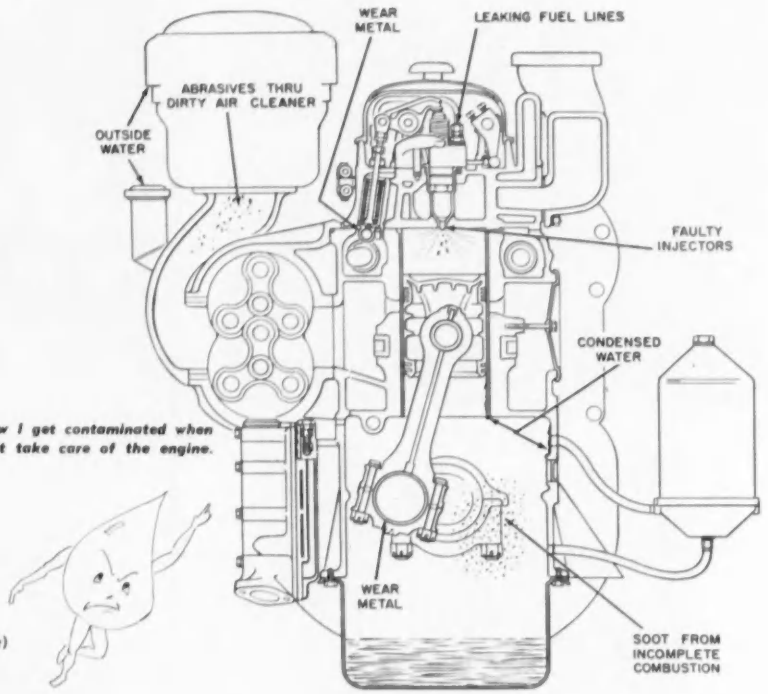
Units selected were three Fairbanks-Morse, model 38D8⅛, 6-cyl opposed-piston diesels, rated 960-hp at 720-rpm. Each drives a 625-kva, 500-kw, 3-phase, 60-cycle alternator with a vee-belted 7½-kw dc exciter.

These engines accepted the responsibility for powering all radar, telemetry, radio-control and cinetheodolite apparatus during test periods, and protecting the base against outside power failure.

Since the stand-by plant went into service June 1953, its peak load has been 1350-kw. A painstaking maintenance routine has paid off in faultless dependability and efficiency—plus economy. Up to Dec., 1954, over 664,000-kw hr were produced at an average of only .380-lb per hp-hr.

There is every indication the high level of performance and efficiency will continue in the future.

Your Oil Speaks Up



Here's how I get contaminated when they don't take care of the engine.

by James H. Kahlke, (Field Engineer)
Pure Oil Co. Technical Service Dept.

In our series of articles on lube oils and filter change practices we've heard from oil refiners, fleet owners, repair shop engineers, oil analyzers and various engine users. Now let's get the facts straight from the oil right in the engine. Mr. J. H. Kahlke, Field Engineer of the Pure Oil Company's Technical Service Dept., describes a used oil analysis from the point of view of a used oil. This used oil is given the ability to speak and tells its own story of what happens in an engine and in a laboratory analysis.

I am oil . . . used crankcase oil. I work inside your diesel engine and I am going to tell you a story about my experiences.

Today it was decided that my usefulness had ended. I knew that this was the end of the road for me when I felt the drain plug in the bottom of my hot dark home removed and I rushed out into the light of the drain pail. Actually, I have few regrets because I have rendered many hours of safe lubrication and protection to the rapidly moving parts of a typical diesel engine.

I know a lot about what is going on inside of this engine that would be very helpful to the owner. No one sees as much of the inside of an engine as I do. During the course of my travels, I visit the crankcase, oil pump, crankshaft and connecting rod bearings, cylinder walls, pistons and all of the many other moving parts. In fact, I get a peek into the combustion chamber during actual firing. Can you match that?

Everywhere I go in the engine I get a first-hand story on operating conditions. Don't think that an improperly fitted bearing doesn't let me know about it. And you can't imagine the horrible experience of being "lugged" under load and can't get enough air.

Yes, if I could talk to the operator I could really tell him plenty. Sometimes I could be used longer than I am. But the operator can't tell very much about my condition which is a mirror of the conditions that exist inside the engine.

Recently I had an experience that might be of interest to you as a fleet operator. It enabled me to satisfy one of my great desires. This desire is to tell you about the inside of your diesel engine. The experience occurred when I was sent to The Pure Oil Company's research and development laboratories, where I was made to tell my secrets. This third degree consisted of being put through a complete used oil analysis.

In this analysis a series of tests removed all the clues I had picked up during my travels in a diesel engine. From these clues, which are the contaminants I pick up, a trained engineer can find out much about the engine's condition.

First, all the fuel and water that I had picked up was boiled off and measured. Normally, very little die-

Results of Analyzing Three Used Oil Samples from Vehicles in Different Types of Service

VEHICLE	*A*	*B*	*C*
Total Mileage	150,000	5670	180,000
Type of Service	Over-the-road	Concrete Transit Mix	Over-the-road
Miles Oil Sample Used	3000	1570	2500
Miles Oil Filter Used	3000	1570	2500
USED OIL TESTS	*A*	*B*	*C*
1. Viscosity @ 100° F.	541	572	832
2. Used Oil SAE No.	30	30	40
3. Fuel Dilution %	0.0	0.0	0.0
4. Total Solids %	Trace	1.8	22.0
5. Tar & Asphaltic in Total Solids, %	S-Trace	1.0	7.0
6. Gums in Total Solids, %	0.0	0.5	9.0
7. Insolubles in Total Solids, %	S-Trace	0.3	6.0
8. Fuel Lead in Insolubles	Normal	Normal	Normal
9. Fuel Soot in Insolubles	Normal	Normal	Normal
10. Carbon in Insolubles	Normal	Normal	Normal
11. Metals or Silica in Insolubles	Normal	Iron	Normal
12. Water, %	0.0	0.0	0.0

"A" is an example of good engine condition and proper operation. Note only trace of solids after 3000 miles on crankcase oil. "B" is an example of a truck being lugged under load. Note fairly high solids content. Driver was instructed on maintaining engine rpm and samples now look like "A". "C" is one of worst samples ever checked. Engineer reviewing this report wired customer to check compression for stuck or broken rings. It was found that rings on one piston were incorrectly installed and stuck in lands.

sel fuel gets into the crankcase because of the excellent fuel combustion of a diesel engine. However there are times when a faulty injector permits raw fuel to get into a crankcase. Also sometimes leaks occur in fuel lines which permit a very large amount of fuel to get into the crankcase. Any self-respecting engine oil hates this fuel dilution because it gets washed off the cylinder walls and thins out so that carefully made precision parts can't be well protected against wear.

While some dilution can be tolerated without damage to the engine, presence of more than 5% reflects a very undesirable condition to the operator. It indicates power loss and that fuel is wasted in addition to the possible damage to and excessive wear of the engine. Fuel dilution from 3% to 10% usually reflects faulty injectors which permit fuel to "dribble" into the cylinder continuously. When dilution is higher there are probably leaks in fuel lines located inside of some engines.

Water, too, is an undesirable contaminant because it causes sludge and rusting of iron and steel parts. Sludge, which interferes with my doing a good job of lubricating, is caused by water emulsifying with the oil and soot. This water may come from condensation, cooling system leaks or from outside of the engine.

When diesel fuel is burned, water in the form of vapor is given off. When the engine is cold the moisture laden gases from the combustion chamber condense on the cylinder walls and in the crankcase. This makes my job of lubrication really rough.

Large amounts of water in the used oil are usually the result of cooling system leaks. When equipment is operated on wet roads or in swamps water may enter through engine openings. Good crankcase ventilation and high thermostat settings help keep down condensation. If the oil becomes mustard-like in color or an oil analysis indicates substantial amounts of water, check the cooling system and oil cooler for leaks.

To get back to my experience, the lab technicians then diluted me with a solvent and put me in the centrifuge. This separated from me all of the junk I had picked up in my travels through a diesel. You might say I was dry cleaned. After this, these solids were analyzed to find out what they were.

One thing they found was tar-like substances. These materials are nasty because they cause varnish deposits and ring sticking. They may come from partially burned fuel or from oxidation of oil. Partially burned fuel results from an insufficient amount of air to burn the fuel or from low compression. Excessive smoking and fuel soot in the oil usually accompany this condition.

Oil ovidation results from using an oil insufficiently inhibited against oxidation or from using an oil too long for operating temperatures encountered in the engine. Oil will oxidize—that is, some oil molecules will combine with oxygen—if oil is not properly inhibited or if the inhibitors which police this reaction are used up. The inhibitors are used up more rapidly as oil temperature increases. When excessive tar and asphaltic matter is found in oil, check:

1. *Air supply*: Restricted air cleaners and "lugging" (operating engine under full throttle and load at low speeds), result in insufficient air supply.

2. *Compression*: Worn rings and burned valves cause loss of compression which results in incomplete combustion of the fuel.

3. *Overheated engines*: Make sure cooling system is not causing overheating which in turn will cause oil oxidation at a greater rate.

4. *Oil quality and change period*: Make sure that the oil is suitable for API service DG (Diesel General). Use oils suitable for DM (Diesel Moderate) or DS (Diesel Severe) service, if the sulphur content of the fuel is over 0.5%. An analysis of the oil after other checks are made will indicate if the change period is too long for the temperatures and operating conditions.

Next, lab technicians removed and measured gums present in the solids. Like tar and asphaltic materials, these gums result from incomplete combustion of the fuel and cause varnish and sludge deposits throughout the engine. These materials seldom, if ever, are formed from oxidation of oil. The injection system, air supply, and compression should be checked if abnormal amounts are found in the engine oil.

After men in the lab checked the gums, tar and asphaltic materials in the solids removed by centrifuging, soot, carbon, metal and dirt were left.

Let's take *soot*. Considerable quantities of soot are formed along with gums and tar and asphalts during

incomplete combustion of fuel. These materials are the source of most of the sludge found in the engine.

In addition to things discussed in preceding paragraphs, use of wrong fuel may cause trouble under some operating conditions. Some engines require a No. 1 diesel fuel for low temperature, intermittent type operation. The use of a No. 2 fuel in these instances results in incomplete combustion and rapid build-up of solids in the oil and filter and deposits in the engine. Check engine manufacturers' recommendations.

Carbon is another thing. If oil is continually exposed to excessively high temperatures extreme oxidation results and coke (or carbon deposits) builds up on the underside of pistons. Engine overheating is the usual cause, although prolonged periods of full load operation may be responsible. Occasionally, when fresh oil is added to used crankcase oil, "coffee ground" solids (roughly classed as carbon) may precipitate from the oil.

As to *metal*, why, at times I feel like a regular scrap pile. I usually carry around iron worn from rings, cylinders, timing gears, oil pump gears and other iron or steel parts. Also metal from bearings and bronze or brass from bushings. These metals are from wear caused by abrasive materials, normal failure of parts or improper installation of replacement parts. The most common source of wear, which is reflected by very fine pieces of iron, is caused by dirt taken in through the engine's air intake. Another important source of abrasives is material left in an engine after a valve or ring job.

These abrasives cause rapid wear, wasted fuel, lost power and premature failures. To prevent this, make sure that: (1) All cleaners are properly maintained to prevent entrance of dirt; (2) All metal chips and grinding materials are thoroughly cleaned from engine after overhauling; and (3) Extreme care and cleanliness are observed in installing replacement parts.

Dirt or dust in oil usually reflects inadequate maintenance of air cleaners and crankcase ventilators. Dirty oil containers might be used in filling the crankcase. The presence of dirt or dust in oil is a sure sign that excessive wear has or will take place in the engine.

Basically, this analysis business consists of removing all contaminants from oil and measuring them. From that point, trained engineers check the figures to see if any abnormal contamination has ooccurred By knowing the sources or causes of various kinds of contaminants, they can tell what is going on inside the engine. The benefits of an oil analysis are:

1. Establish maximum safe oil change periods—make sure that you are getting the most for your dollar by not using the oil too long or draining too soon.

2. Serves to reflect conditions inside the engine long before failures and expensive repairs are necessary—much like a doctor diagnosing certain human ailments through blood analysis.

3. Gives you periodic checks on maintenance and operating conditions. This helps you check the efficiency of your maintenance programs.

4. Helps discover the cause of troubles that may already exist in your operation.

Many oil companies provide oil analysis at no charge as a service to their customers. Results from analysis of three typical oil samples taken from files of the Technical Service Dept. of the Pure Oil Co. are given in tabulated form. These charts show how various amounts of different contaminents in the oil give an indication of the probable causes for this contamination. The captions explain the cause of contamination for each of the oil samples.

This is my story—the story of a pint of used oil. But let the oil from your engine speak up and tell you their story with the help of a used oil analysis. It's worth listening to.

What Do You Know!

Here are some questions to test your general knowledge of the diesel field. Make your selections, then turn to Page 80 to check them.

1. In comparing factors which determine why you would buy one high-speed diesel in preference to another, place the following in the order of their importance in making your decision:
   a. First cost.
   b. Performance.
   c. Factory parts and service availability.
   d. Desire for uniformity.

2. Operating characteristics of gas turbines give performance very similar to torque converter-engine combinations. They produce high low-speed torques.
   a. True b. False

3. As compared to diesels of comparable bore size, free-piston engines have shown:
   a. Less sensitivity to different fuels.
   b. More sensitivity to different fuels.
   c. Same sensitivity to different fuels.

4. The length of the piston stroke of a free-piston engine is variable:
   a. True b. False

5. Thermal efficiencies of open-cycle gas-turbines in the 1000-hp range and higher are in the order of:
   a. 15-16%
   b. 22-24%
   c. 32-34%
   d. 40-42%

6. A muffler is least effective when it is located at the:
   a. Beginning of the exhaust system.
   b. Middle of the exhaust system.
   c. End of the exhaust system.

7. An elaborate system of keeping records should be devised for your preventive maintenance program so that certain jobs are done on time.
   a. True b. False

New Gas Turbine Demonstrated

Clark Bros. shows features and performance of 1000-hp range gas turbine built under British license.

CLARK Bros., one of the Dresser Industries, now has a baby brother to its 8500-hp gas turbine. The new unit, the Mark TA, is rated 1130-hp and will be made under a licensing agreement with Ruston-Hornsby Ltd., of England. Gas turbines of this particular horsepower-range are said to be unavailable in this country.

Light weight, compactness, air cooling, fuel flexibility, and ruggedness, make these units suitable for stationary and portable generator sets, compressor and pumping units and for marine use. Over 40 of these units are—or will be in operation shortly in Europe, Africa and Asia. Best overall efficiency is realized in these units when the application requires a combination of waste heat recovery and power output.

The Mark TA operates on an open cycle. It is a dual-shaft, series-flow unit developing its rated power at 80°F at 1000-ft altitude. However a 3.5% reduction in output is required for every 1000-ft increase in altitude. And for each 10°F above or below 80°F there's a 5% loss or gain in output.

Axial Compressor

Air for combustion and cooling is supplied by a 13-stage axial-flow compressor driven through a flexible coupling by the high-pressure turbine at 11,500-rpm. About 22-lb/sec of air at 4.0 pressure ratio is delivered by this compressor. For easy accessability and assembly the compressor has a horizontal split case.

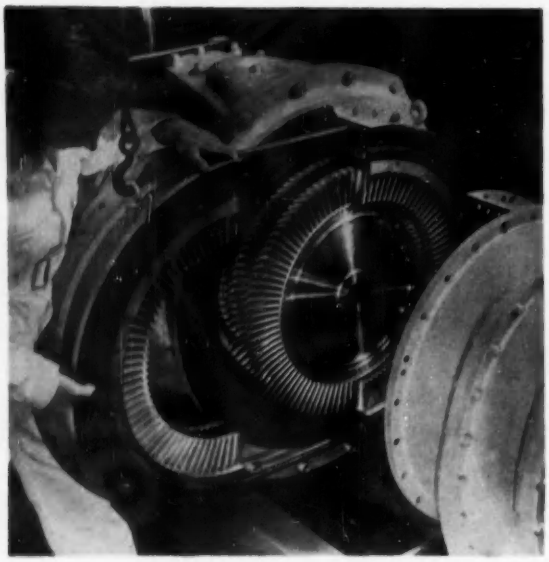
Combustion Chamber

Fuel is burned in a single, elbow-type combustion chamber with a single burner and fuel atomizer. The chamber consists of two shells forming an inner combustion area and outer annulus. The inner liners should never have to be changed. The combustion chamber can be mounted in a number of different positions to suit installation requirements.

A wide range of liquid and gaseous fuels can be burned efficiently according to Clark engineers. The unit demonstrated at Clark's plant used diesel fuel. However, a change to gas can be made within 30-minutes. It's just a matter of disconnecting the fuel pump, changing the nozzle and piping and installing a governor suitable for gas service. A combustion chamber with two nozzles—one for oil and one for gas—is being developed to eliminate this loss of time in switching over.

Turbines

The high-pressure turbine is a two-stage unit operated by the expanding heated gases from the combustion chamber. The larger diameter low-pressure or output-turbine, also two-stage, turns at 6000-rpm operated by



Both two-stage turbine and stator are readily accessible. Stator casings can be removed without disturbing intermediate duct. Turbine and stator blades can be inspected one hour after shutdown.

Typical heat balance for open-cycle gas turbine. Only 16% of fuel Btu's available for power. Excessive heat in exhaust used to produce steam.

the energy remaining from the hot gases from the high-pressure turbine. The rotating blades are machined from bar and are unshrouded. The blading of both compressor and turbines is designed on the free vortex principle. Turbine blades are anchored to high temperature stainless steel discs by broached, fir-tree type serrations.

Stator blades are also machined from bar and mounted in 12 segments which are free to expand without disturbing the outer casing. Both blade roots and discs are cooled by air taken from the compressor. A flexible intermediate duct between the two turbines is easily removed for accessability.

Planetary Gear

For 50 or 60-cycle generator drive, a built-in planetary gear can be supplied which reduces turbine speed from 6000-rpm to an output shaft speed of 1500 or 1800-rpm. The output is taken from the planet carrier. The annulus, although stationary, is allowed to float to accommodate any slight discrepancies in the gears.

The governor, main lube oil pump, overspeed trip, tachometer, hours counter and liquid fuel pump are all driven from a gear mounted on the planet carrier running at 1800-rpm.

When a direct drive at 6000-rpm is required, a straight through shaft fitted with built-in flexible-gear type couplings is furnished. The turbine-driven auxiliaries which run at 1500-rpm are driven through a double reduction gear.

Bearings

Interchangeable precision bearings are of the thin-walled, steel-backed type. They're lined with babbitt for the compressor and with copper-lead for the turbines.

Lube Oil System

The main frame forms a 100-gal reservoir for lube oil. The lube oil pump, driven by the low-pressure turbine, feeds oil to a cooler and full-flow filter. Then oil flows to bearings and other components and returns to base. Oil is cooled either by an air-blast cooler or water heat exchanger, depending on the installation. An auxiliary motor-driven pump automatically provides oil for bearings and control system before starting.

Control System

Unit control is based on a hydraulic servo system fed from the lube oil system at 50-psi. This arrangement automatically cuts off fuel and shuts down unit if lube oil pressure drops low enough.

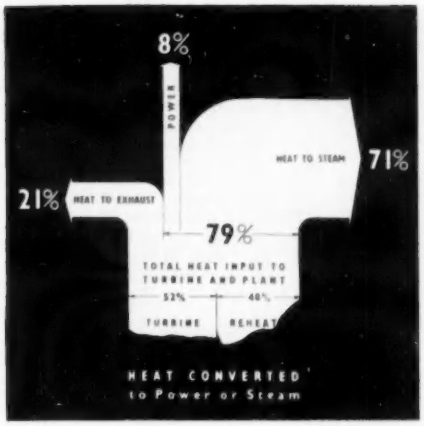
Speed droop can be adjusted but unless otherwise specified, it's set to 4% for parallel operation. When load is suddenly increased about 25% of full load, transient speed variation is approximately 5%. On sudden load reductions of 25%, transient speed variation is about 3%. Speed may be controlled by buttons on the control panel. These buttons can also be installed on a switchboard to facilitate synchronizing and application of load when necessary.

Liquid Fuel System

A gear pump delivers fuel from the tank, through twin filters, via the control equipment to the burner. Delivery pressure is controlled by the governor depending on load. The burner swirl-chamber, fed by trangential passages, discharges fuel into combustion chamber in an atomized spray. The nozzle is shrouded and air cooled. At start-up fuel is fed by a motor-driven auxiliary pump which is automatically cut out when turbine reaches operating speed.

Starting System

Starting is accomplished by turning a hand wheel on control panel. This wheel turns through five positions. The first position starts motor-driven auxiliary oil pumps.



When after-burner is used in boiler to burn excess oxygen remaining in exhaust gases to produce more steam, only 8% of Btu's are used for power.

Second position engages the 30-hp, 24-v, starter motor to the compressor shaft. The next wheel position ignites pilot light in combustion chamber. Fourth position makes fuel cut in. When wheel is turned to last position, fuel begins to burn, compressor accelerates to 5000-rpm, and starting motor cuts out. The compressor and high pressure turbine continue to accelerate to 6000-rpm at which speed the governor takes over and turbine-driven auxiliaries automatically cut in.

Protective Devices

Protective devices are incorporated which prevent the starting motor from turning the compressor without lube oil pressure at bearings. In a gas-fired unit, ignition is prevented before the turbines, combustion chamber and ducting, have been purged with air from the compressor during normal starting cycle. The unit is also automatically shut down in case of overspeeding or loss of lube oil pressure as previously mentioned.

Installation

Compressor discharge, turbine inlet and compressor inlet volute can be rotated to any one of 24 positions for ease of installation. Exhaust ducting can be arranged for either up or down connections. The turbine, weighing about six tons, can be supplied on a skid-base which requires no foundation. It can also be furnished with a 2-piece base to facilitate transportation. Three point support of the unit assures proper alignment.

Efficiency

Thermal efficiency at full and part loads are as follows. At 100% load, 15.2%, at 75% load, 13.4% and at 50% load, 11%. When maximum fuel economy is desired, a regenerator can be furnished. Heat from exhaust gases is then used to pre-heat air going to combustion chamber, thus reducing fuel consumption. This boosts thermal efficiency at full load to 20.8% but the continuous rating of the unit would be lowered from 1130-hp to 940-hp.

Ground pressure of only 4 inches (lower than that of a man) made the D8's with 54-in tracks, excellent in snow.

Cats Work in the Cold, Too

OPERATION Deepfreeze used especially-constructed Caterpillar equipment on Deepfreeze I, the taskforce recently returned from Antarctica. "Well done and indispensible" was the operation officer's description of the equipment. The navy report stated that the machines "performed extraordinary work unloading cargo ships and ice-breakers under extreme climatic conditions."

Preparing for Deepfreeze 11, an additional $1 million order has been placed with Cat. The Seabees already have eight LGP D8 tractors, nine LGP D2 tractors, three LGP D4 tractors and sixteen Cat electric sets. This certainly testifies to the job the diesel rigs did.

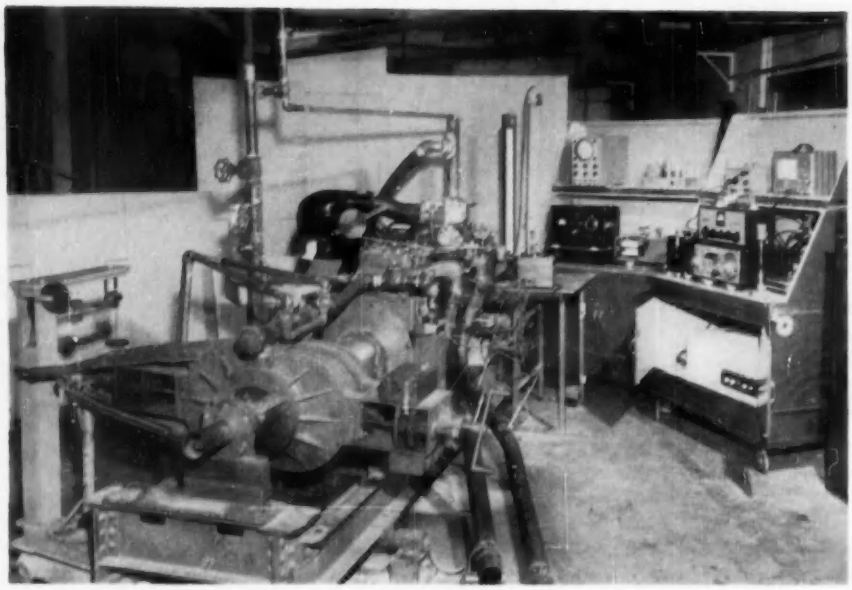
Due to the treacherous nature of the ice, tractors ran the empty sleds out to the ships. Then they came ashore while the sleds were being loaded. Later they were winched ashore and pulled away.

Most of the time, the tractors were able to haul three 11-ton sleds with a 15-ton payload in third gear. Other systems were used, though, for example the smaller D2's hauled the sleds to the foot of the shelf ice. Here a series of 5% grades began. The D8's took them from there. In all, about 500 trips were made over distances up to 4½-mi.

Trail maintenance was constant. One LGP D8 with a dozer blade was used almost full time in this capacity. These were also used to clear powder off the camp sites preparatory to construction. Compacting rollers then compressed the remainder.

The tractors were given careful servicing. Fueling and greasing, and the removal of packed snow from around rollers and sprockets was done by the operator. He did it during the day as necessary; but also at the end of each shift. Periodic preventative maintenance checks were made by Seabee mechanics. Many of these men had been trained at Caterpillar last summer.

The Navy's next Antarctic venture, Deepfreeze 11, will be located at approximately Latitude 80, Longitude 120 ,about 600-mi from Little America. Naturally, the Cat diesels will be ready for the task.



Typical test set-up for muffler analysis. Water brake dynamometer is used for load control of 200-hp diesel shown on test. Thermocouples are installed for various temperature readings. Manometers are used for checking back pressure. Sound equipment is for visual and recorded information on sound power level, sound wave shape, sound frequency curves and, octave band readings.

How To Choose A Muffler

By Leino H. Billey
Supervisor, Muffler Engineering
Donaldson Co., Inc.

Choose a muffler intelligently and you'll have quieter operation with less muffler repairs. You'll read about proper sizing, best materials used, location in exhaust system, effects on fuel economy and engine operation, performance and tone characteristics.

WHO should choose the muffler for a diesel engine? How should this muffler be chosen? Obviously the original equipment manufacturer is in the best position to do this.

He knows and can determine what meets the needs of his product best, both engineering-wise and public relations or sales-wise. He has knowledge of the total muffler field and what is available to meet his needs. He has the best control over the quality and suitability of the muffler he chooses.

Trusting the original equipment manufacturer's choice makes the user's problems much simpler. He has no engineering problems to solve. The muffler fits and installs readily. It performs to the original equipment standards. Further, the user has good recourse in case of installation or operating difficulties. The following discussion is therefore intended primarily with the original equipment manufacturer (who chooses the equipment) in mind.

However the choice of a muffler is no simple matter even to the original equipment manufacturer who has engineering and laboratory facilities to help him. He has three major factors to consider. These are (A) size and appearance, (B) cost and (C) availability.

Under the factor (A) "size and appearance" he must consider installation space, appearance and fitness, and performance. Under performance must be considered suitability, tone or sound quality, sound level, effect upon engine temperature, backpressure and influence on life of valves, heads, manifolds and exhaust pipes.

Under factor (B) "cost", fall costs of his muffler engineering and testing, choice of materials, transportation and handling, ease and speed of installation, and other production costs such as for brackets, mounts, guards, weldings, etc.

Finally under (C) "availability", fall the factors of reliability and capacity of vendor and the production standards and quality control the vendor exercises.

These and many more are the burdens resting upon shoulders of the one who chooses the muffler. The following should ease and clarify some of these burdens.

Muffler Volume And Dimensional Proportions

Usually the customer specifies the physical dimensions his installation allows for the muffler. Often these dimensions are inadequate for the requirements of the job.

It is well to remember that the ratio (R) of length (L) to diameter (D) has a definite bearing on silencing. A squat muffler of relatively large diameter attenuates most over a narrow band of frequences. Conversely a slim muffler attenuates a lesser amount at any one region but over a wider band of frequencies. This latter provides a much better tone.

The minimum practical ratio of length to diameter (R(L:D)) is in the range of 2 to 1. In other words, L = 2D. For example, 9 OD x 18, or 7 OD x 14, or 3 OD x 6. The usual ratio, (R(L:D)) is more in the range of 4 to 1.

A very effective ratio for uniflow (or straight-through) mufflers is 6, 7, or 8. With this ratio, if other factors are the same, one can provide, for example, a 125 sone muffler in straight-through design. If the ratio is much less, one must design a "folded" or "3-pass" flow to approach the required sound level and tone.

The following equation will help to determine the approximate volume required in the muffler. Customer needs vary but this will serve well in most applications.

$$\text{Volume (VOL)} = K \frac{PD}{RPM} \sqrt{\frac{I}{N}} \text{ where}$$

K = the constant or factor as follows:—
5.0×10^3 for farm tractors
10.0×10^3 for off-highway and contractors equipment
35.0×10^3 for over-the-highway trucks
50.0×10^3 for passenger cars
PD — piston displacement of engine
RPM = revolutions per minute, maximum operating speed
N = number of cylinders
Note: The above applies to 4-cycle engines.

For 2 cycle use $\sqrt{\frac{I}{2N}}$

Note: Where dual exhaust systems are used, each muffler should be equal in volume to $\sqrt{.5} = (.707)$ of the volume indicated by above formula.

Where two exhaust pipes, each serving one-half of the engine, enter into one muffler the volume should be equal to the sum of the values when calculating each half as a separate engine. The result is a volume equal to the $\sqrt{2} = (1.414)$ times that of a single exhaust pipe system.

To determine dimensions, L and D from the volume:

$$\text{Dia.} = \sqrt[3]{\frac{4/\pi \text{ VOL}}{R \quad (L:D)}}$$

Length = dia. X R (L:D)

Muffler Materials

To aid one in choosing a material for mufflers, it is well to understand more fully the total problem. For example, what materials are customarily used, what the muffler's "natural enemies" are and a little about engineering and production problems.

Let us list first the 11 most common "natural enemies" of the muffler:—Rust caused by water; Corrosion caused by acids; Electrolysis, in mufflers where condensation does not drain or dry up; Corrosion caused by salts; Erosion, or eating away by hot, fast moving exhaust gases; Heat, causing bulging, buckling, deformation of metals having insufficient tensile strength under the operating temperature; Thermal shock stresses (cold water splashing on hot muffler); Impact shock stresses (gravel, stones, careless handling, dropping); Vibration and fatigue (causing cracking and failure); Freezing and thawing of internal condensation; Tampering and modification of muffler.

The following are common muffler materials: Uncoated materials used, are black iron and low-alloy, high-tensile iron.

Coating materials used, are lead or terne plate, and aluminum (or aluminized).

Materials used for coating after fabrication, are zinc (or galvanized) and glass (or ceramic coat).

The stainless varieties materials used, are chromium (series 400) stainless, nickel-chromium (series 300) stainless and inconel, the premium alloy.

Costs of the raw material and fabrication are important factors. Lowest first cost and lowest fabrication cost is achieved with uncoated materials. They are the easiest to shear, press, form and weld, therefore, most rapid in production. This makes final cost low.

Stainless varieties vary in first cost, but are 5 to 15 times more costly than uncoated black iron. They are more difficult to shear, press, form and weld, therefore, slowest in production. Final cost is very high.

Coated materials offer inbetween qualities at a cost only slightly more than the lowest. They are easy to fabricate resulting in rapid production and require no painting, further reducing cost.

Most everyone is familiar with rusting and corrosion of uncoated muffler materials. They are prey to the first six listed enemies of mufflers.

Stainless steels are well suited, except that they must be carefully designed to avoid vibration and fatigue. It is important, too, to select the type best suited for mufflers. Some are not well suited and a poor choice may end in a costly muffler of questionable endurance.

A study of coated materials reveals some very interesting facts. For example, lead coat or terne plate burns away completely in truck use or any comparable hot service and one has only an uncoated base sheet steel muffler. Except for certain passenger car-type service, terne coated mufflers offer no advantage.

The zinc-coated (or galvanized) and the glass coated (or ceramic) mufflers are coated after fabrication. They

must be designed for dipping and rapid draining and in ceramics for thorough and equal firing or baking. The better acoustical (or silencing) designs do not lend themselves to these requirements. Therefore, "coated after fabrication" mufflers are at best, a compromise in silencing characteristics. Further, zinc coating burns away at slightly higher temperature than terne coat, leaving only base sheet steel unprotected.

Ceramic coatings are mainly used in duct work aircraft exhaust systems since mufflers are not used. Ceramic coatings for truck mufflers are particularly subject to impact shock stresses which are not generally visible externally but start as a crazing or crackling on the inside, eventually exposing the base sheet steel. In cold climates, freezing and thawing of internal condensation also attacks ceramic coated mufflers.

Aluminum coating is interesting in that it is transformed or processed after initial heating of the muffler. The aluminum becomes hot, and excess coating appears to run off and "puddle" in the cooler areas. The remaining aluminum combines with the sheet steel to form an iron-aluminum alloy which does not return to its original state after formation. This coating is a refractory or firebrick-like material electrically non-conducting and immune to all but excessive heat and tampering.

Except for deep drawing, aluminum coated steel can be processed just like mild steel. The muffler can be designed to the best known acoustical designs and fabricated to high standards from it. Welding processes require a bit better class of equipment but once setup, production control is easy and output is rapid.

The mufflers may become coated with road dust, mud and grime but scrape off the dirt and underneath you will find a surface fully protected from rust and corrosion. It may be battered and dented but the coating still adheres. When you know all the factors, aluminum coating will be your choice for most muffler applications.

Muffler Location

One may ask "Does the muffler work best near the engine, or is it better at the end of the exhaust system or what about the middle?" An investigation was made to find the answer. The results were so interesting that two separate independent tests were run about two years apart, by two different research groups. The results agreed closely. Following are a few pointers based on these results.

Position of the muffler along the exhaust system becomes more critical as the system is extended in length. A power unit with a close coupled muffler and a short tailpipe represents no problem. An under-the-chassis muffler in a gasoline-powered truck is not too critical either. A cabside installation on a diesel-powered truck where the total system length is from 15 to 25 feet is a typical problem.

The most critical is the position of a muffler on a long stack extending along the wall of an elevator building or a feed mill, or in a generating plant.

The investigation shows that there is definitely a "good" and a "bad" location for the muffler. The tabulation below prepared from test data proves this. The engine used is a 200-hp diesel operating at full load at 2100 rpm. The exhaust system is a typical truck-set-up, 23 ft 2 in from the manifold flange to end of tailpipe. The muffler used was not of the straight-through type but typical of many used on trucks today. A brief study of the table will reveal some interesting facts.

Muffler Location No.	Exhaust Pipe Length	Tail Pipe Length	Muffler Back Pressure	Sound Drop Decibels	Sound Coming Through	Back Pressure Rise
1	4 ft	16 ft	.95" Hg	13	5%	135%
2	7 ft	13 ft	.71" "	16.5	2¼%	100%
3	10 ft	10 ft	.83" "	7.5	18%	117%
4	13 ft	7 ft	1.01" "	10.5	9%	142%
5	16 ft	4 ft	.73" "	13.5	4½%	103%
6	19 ft	1 ft	.72" "	8.0	16%	102%
None	23 ft 2 in	0 ft	Base	Base	100%	Base

What causes all this? In an exhaust system we find what electrical and acoustical engineers call "standing waves". These are set up and kept in vibration by engine exhaust impulses. They are related to exhaust system length, gases temperature and frequency of engine exhaust slugs. Each wave form has a node or several nodes or regions of minimum activity or disturbance, and corresponding anti-nodes or regions of greater activity or maximum disturbance. A muffler located at a node has more restriction or backpressure and does less silencing.

A muffler located at the anti-node has less restriction or backpressure and does more silencing.

That is what the table shows. All you do is find the greatest anti-node and place the muffler in that region. The longer the system, the more powerful these standing waves may become. That is why it is more important to locate the muffler correctly in the longer system.

The best location is the 1-2 position. This means that the tail-pipe is twice as long as the exhaust pipe, or in other words, exhaust pipe equals 1, and tailpipe equals 2. A very good location is the 4-1 position, or where the tailpipe is ¼ as long as the exhaust pipe. The middle of the system is the worst position.

It isn't always possible to put the muffler in the best location, but when one knows what these locations are, he can try for the best and avoid the worst.

Why Use A Muffler?

Have you watched Joe Palooka doing his workout? You've seen him, and heard the sound of that bag. Pretty good trick. Maybe you've tried it a time or two. The idea is to strike the bag hard, exactly at the correct moment and to keep time with it so every time it comes forward you reverse its motion. It absorbs energy and builds up Joe's muscles. Sending the bag back and continuing to send it back with unbroken rhythm is a form of *resonance*.

In the case of Joe's workout, it is resonance "out-of-phase" or in opposition. No useful work is done. Consider now the springboard. A diver using a springboard must also be in resonance with the "spring" of the board.

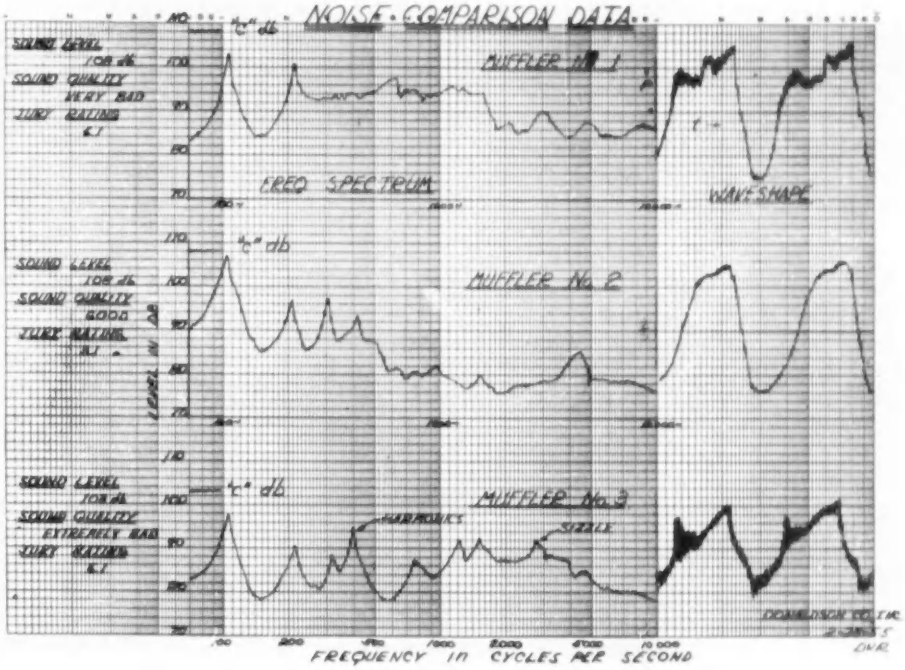


Chart 1:
Wave shape of muffler No. 2, is much smoother than that of No. 1, and there is less fuzz, but the sound level for both is the same. There are more high frequency noises (high pitch) for No. 1, than No. 2, causing more fuzz, Muffler No. 3, has sound level 5 decibels lower than No. 2, but is rated noisier. Bad fuzz on wave shape called "sizzle" indicates too many high frequency noises.

In this case, his resonance is "in-phase" and the energy he imparts into the board is returned in useful effort. The driver bounces farther and more gracefully.

But you say, "what has this to do with muffling, and what has muffling to do with fuel economy?" So let's take it in steps. Anytime the engine blows black smoke it is a sign that some of the fuel is "cracking" and not burning. This can be caused by various things. For example, a restricted air intake supply does it. Violent or "uncontrolled combustion" as the engineer calls it is another cause. Interference to free exhaust flow is still another. We'll discuss the latter.

We mentioned "standing waves" in the exhaust system. When these standing waves are out-of-phase they are in effect just like an invisible Joe Palooka's punching bag—always moving in opposite direction to the exhaust gas slugs.

Inadequate or no muffling sets this "bag" into violent motion within the exhaust pipe. If the exhaust pipe is of correct length in relation to the rate of firing, this type of resonance results in severe exhaust noise "crack" and black smoke. Every slug of exhaust trying to escape is opposed by the resonant wave.

The result is unburned fuel and loss of power because all fuel that could be burned to produce power is not used, but is wasted. However, these standing waves or resonance can be used like the springboard to aid exhaust flow. This is a practice employed in stationary power plants where the engine speed is constant and the exhaust system length can be matched with the speed.

So what can one do? First, choose a muffler that cuts this resonance to a minimum, and secondly, be sure to place it in the most effective location in the system. Be sure to get a muffler designed specifically for the vehicle or other application you install it on. Choose from a manufacturer who has a staff of engineers and research facilities to provide correct muffler design.

What is the gain? Greater economy because more fuel is burned usefully. More power because a greater portion of the fuel is burned under better cylinder conditions. Less trouble from stuck piston rings, cracked heads, valves and manifolds. Less exhaust noise and "crack" meaning better public relations.

How An Engineer Chooses A Muffler

What is involved in determining the performance characteristics of a muffler? A muffler for a specific application must perform at a suitable back-pressure with the required degree of silencing and sound quality. In accomplishing this it must provide the desired results with proper engine economy.

To make comparisons of operation between one muffler and another, and to assure one of the value of a given design, he must be equipped for the complete range of testing activities. With dynamometers it is possible to load an engine and simulate actual performance.

Under different load conditions, pressure drops are measured at different points in the intake and exhaust system by means of manometers. Thermocouples at various points in the exhaust system provide a means of

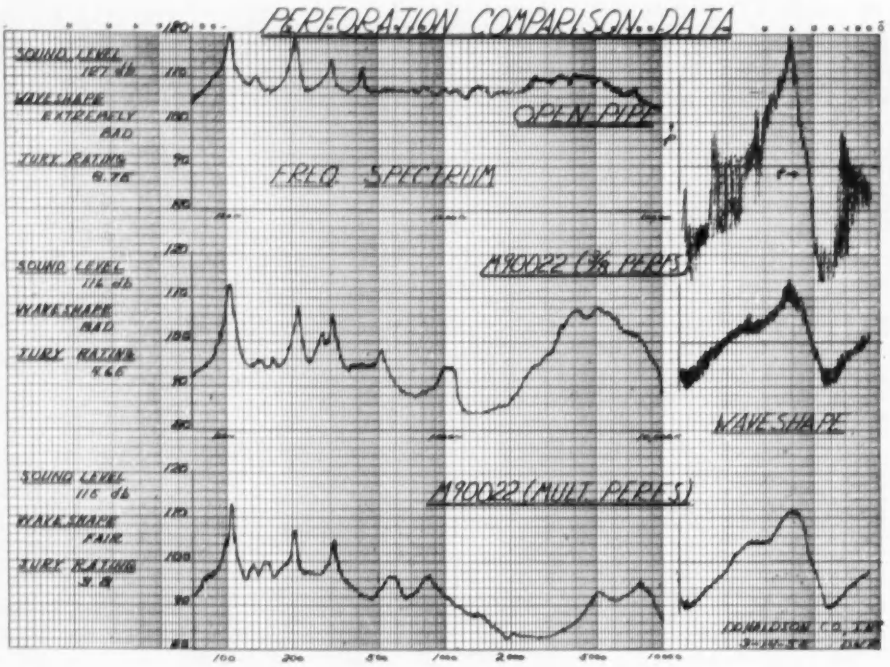


Chart 2:

Comparison of exhaust noise in open pipe, muffler with 3/8-in perforations and muffler with multiple-size perforations. At 4000 cycles per second, 3 decibels are removed from muffler with 3/8-in perforations while 24 are removed from one with multiple-size perforations. Little change is made in lower frequencies. Bad properties of 3/8-in pattern have been greatly improved without loosing any of the good ones. Noise is more pleasant to listen to.

temperature measurement through the use of the potentiometer. Sound readings are taken by means of a microphone placed at various positions in relation to the muffler.

The noise, as a signal received by the microphone, is indicated on an oscilloscope and sound level meter. In addition, the automatic frequency response recorder is used for recording all noise levels in the range of frequencies from 25 to 7500 cycles per second. The noise is also recorded on a magnetic tape which can be used later for "play back" in comparison against another muffler. By means of the recorded information on the magnetic tape, the sone levels of the different bands are determined and added to obtain the final sone rating.

A proper design of muffler must provide good sound quality at a suitable noise level. By means of noise frequency analysis in addition to decibel sound measurements, the two factors can be properly judged and compared. With numerous tests and background of knowledge and data, it is possible to pre-determine to a large degree, the results that are obtained for a given muffler. This makes it possible for muffler engineering to "tailor-make" a muffler for the given requirement, without excessive experimentation.

Muffler Tone

There are sounds that are pleasant to hear and there are those that are but rank noises. We all know the difference when we hear them. But a technical description of a good sound and a bad one is not generally understood by the layman. In the muffler business it is important to know what makes a good quality sound and not just a noise.

By obtaining considerable sound recorded data on magnetic tape, at the fourth California Motor Truck Association Muffler test in 1953, it was possible to compare many different mufflers. A jury of 21 men rated all the mufflers—and these ratings were later correlated by wave shape and frequency spectrum. In this manner, an ideal sound quality curve is established.

What makes a noise noisy? Look at the chart No. 1 for mufflers No. 1 and No. 2. The wave shape of No. 2 is much smoother than No. 1, and there is less fuzz, but the sound level for both is the same. Note that there are more high frequency noises (high pitch) for No. 1 than No. 2—it is the high frequencies that give the fuzz to the wave shape. Obviously, muffler No. 2 sounds better than No. 1. It has better sound quality, and the jury rated it 3.1 as opposed to 6.1 for muffler No. 1. (The jury rated all mufflers from 1 to 10—1 being the best and 10 the worst.)

Now look at muffler No. 3 as compared to muffler No. 2. Its sound level is 5 decibels lower, but the jury rated it as noisy. The reason for the higher noise rating was that it sounded noisier. Why? It had a very bad sound quality. Note the bad fuzz on the wave shape, this we call "sizzle", which indicates too much high frequency noises.

Two factors are of major importance in muffling, the decibel rating, and the sound quality. Both are bonded

closely together and one cannot be considered without the other in providing a superior design.

How To Acquire Nice Tone

The sound level meter measures only a part of sound quality. The other part, waveshape, can also be measured and is shown on chart No. 1. These curves show the shape of the sound wave created by one exhaust discharge and illustrate graphically how pressure changes with time. Since this represents the blowdown of one cylinder, for a 6-cyl., 4-cycle engine at 2100 rpm 105 of these pressure changes take place every second. This 105 cycle per second is shown in the frequency spectrum and is the maximum peak in each curve.

The frequency spectrum is a breakdown of the wave into its various components. This allows one to make an exact study of the various contributing parts.

Chart No. 2 shows the difference in exhaust noise using three different systems; with an open pipe, a muffler using 3/8-in perforations, and the model which has the multiple size perforation pattern. Other than the perforation patterns, these mufflers are identical.

In comparing the waveshapes, most of the fuzz is an indication of a high-pitched "sizzle". One can determine how much has been removed by referring to the frequency spectrum. At 4000 cycles per second, 3 decibels have been removed by the muffler using 3/8-in perforations while 24 have been removed by the multiple-size perforations. The 4000 cycles per second frequency was referred to because the ear is most sensitive to sounds of this pitch.

One can also notice that little change has been made in the lower frequencies, that is, the bad properties of the 3/8-in pattern have been greatly improved without loosing any of the good properties. This change improved the jury rating from 4.65 to 3.3. Or the exhaust noise was more pleasant to "listen to".

Why does the multiple size perforation pattern do a better job? The reason is that perforations of a uniform diameter attenuate to a greater degree in their characteristic frequency band. Smaller diameter perforations attenuate most readily at the higher frequencies, while larger diameter perforations attenuate most readily at the lower frequencies.

A graduated multiple-size perforation pattern will attenuate across the entire audible spectrum and can be readily adjusted to attenuate the most at any point where it is necessary. Because of this, mufflers with the multiple-size perforation pattern will out-perform any muffler in a similar sized package using a uniform size perforation.

Do Not Overlook Backpressure

The U-tube manometer is commonly used to predict the effect of an exhaust system on engine performance. The reading is referred to as backpressure and is measured in inches of Hg. If the reading is low enough, it is generally felt the exhaust system will be acceptable.

Because of its common use, it is well to know just what is being measured and what the limitations are of the manometer. Technically, backpressure is the force required to push a volume of gas through a restriction. As the amount of restriction is increased, more force is required, hence higher backpressure.

Because of the unevenness of the engine discharge system, the exhaust flow has severe pulsations. It is the intended job of the manometer to integrate these pulsations and give an average reading. *In most cases it does not!*

The manometer will give fairly accurate readings when the backpressure is very high (above 3-in Hg), however, as the restriction decreases, the amount of error in reading the resulting backpressure increases. The error is large and can result in confusing data. As an example, a long system may have a lower backpressure than a short system, or an exhaust system may have a higher backpressure with the engine at a lower horsepower output than a higher one.

The pressure pulsations already referred to have amplitudes in the vicinity of 2-in Hg. These pulsations set up standing waves in the exhaust system. That is, the pulsations can be greater at one point than at another. Because of this, backpressure will change with any change in manometer line position. Also, because of standing waves in the manometer lines themselves, any change in line length will also cause different readings.

When the restriction of a muffler is low (less than an inch of Hg), backpressure will decrease as silencing increases. It is common for a good muffler to decrease the backpressure below that of a straight-pipe system. This is effected by decreasing the standing pressure waves. In addition, it may be said that backpressure helps, but is not essential for good muffling.

The amount of error in reading backpressure can be decreased by decreasing the pressure waves in the manometer lines. This is accomplished by employing a small, efficient muffler between the manometer and the exhaust system. Fairly reliable readings are made this way.

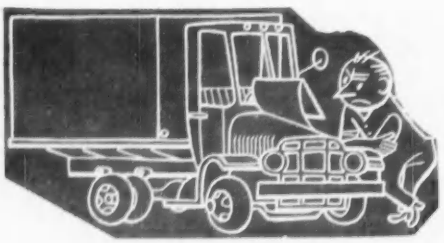
To sum up, the common manometer is an undependable instrument when measuring backpressure and is not a good substitute for a laboratory test when predicting engine performance (fuel economy, horsepower output, and exhaust system temperatures). However, more dependable readings can be obtained if precautions are taken to keep pressure waves in the manometer lines at a minimum.

Conclusion

When choosing a muffler one should consider the following factors.

Why did the original equipment manufacturer choose the muffler that he did? If the muffler you are considering is not used as original equipment why is it not?

There is an increasing tendency among manufacturers to supply better replacement parts than the original equipment. This is particularly true of mufflers. Check to learn if this is not true in your case.



Controlling Costs with a Simple PM System

Details of a simple, effective and "ready-made" preventive maintenance control system. Designed for bus and truck fleets, its principles can be applied to all operations.

DID you know that if you're engaged in interstate transportation the ICC requires you to have a preventive maintenance system with records? It's a matter of law.

There's another little law too—the law of economics that demands a PM system. The penalty is excessive operating costs.

But there is nothing in either law that says you have to have an elaborate, involved system. In fact, the simpler the system, *providing it will do the job*, the better your chances of getting it carried out.

There are two phases to any PM system—the actual mechanical work and the record system. There's no chance of skimping on the mechanical end; you do all necessary jobs or suffer the consequences. Of course, the quality and availability of facilities, tooling, skills and techniques used will spell out the cost factors.

It's the record-keeping that makes or breaks the whole operation. The clerical end of the PM system is no place for empire-builders. Someone with a flair for this sort of thing can dream up a system that will take a Univac to figure out. At the other extreme, poorly kept or inadequate records are worse than none; they take up time for no useful purpose.

All this might be a tough job if so much time had not been spent on working out practical systems. Individual shops, engine builders and oil companies have all done it. With shops, it's their bread-and-butter; in

LUBRICATION EXCEPTIONS

PART	LUBRICANT	CAPACITY (Quarts)	REMARKS

CAPACITIES AND OTHER DATA

ENGINE	MAKE	TRANS. MISSION	MAKE
	MODEL NO.		MODEL
	SERIAL NO.		
	CAPACITY (Quarts)		CAPACITY (Pints)
DRIVE AXLE	MAKE	TRANSFER CASE	MAKE
	MODEL		MODEL
	CAPACITY (Pints)		CAPACITY (Pints)
COOLING SYSTEM		POWER TAKE OFF	
	CAPACITY (Quarts)		CAPACITY (Pints)

MONTHLY GASOLINE AND OIL RECORD

	YEAR 19					YEAR 19				
MONTH	TRUCK OR BUS NUMBER	GASOLINE		MOTOR OIL		MONTH	TRUCK OR BUS NUMBER	GASOLINE		MOTOR OIL	
		TOTAL	MILES PER GAL.	TOTAL	MILES PER QT.			TOTAL	MILES PER GAL.	TOTAL	MILES PER QT.
JAN.						JAN.					
FEB.						FEB.					
MAR.						MAR.					
APR.						APR.					
MAY						MAY					
JUN.						JUN.					
JUL.						JUL.					
AUG.						AUG.					
SEP.						SEP.					
OCT.						OCT.					
NOV.						NOV.					
DEC.						DEC.					

VEHICLE HISTORY

ITEMS OF IMPORTANCE, SUCH AS REPAINTING, BODY REPAIRS, MAJOR OVERHAULS OR REPAIRS, ACCESSORY PARTS, ETC.

the other two categories, it's a matter of service with an element of "self-defense" thrown in.

If you are starting an operation or checking up on your existing system, it pays to take advantage of these services. Let's take a look at the PM system worked out by Socony Mobil Oil Company. Incidently, it is ICC-approved. An immediate "plus" factor is that the necessary forms are free for the asking.

Socony Mobil engineers have worked out a system that achieves simplicity, a minimum of paper-shuffling, and still provides accurate answers to all items needed for a good mechanical operation. There are only three elements involved: a record folder; a work sheet; and a control blackboard. The latter is not provided but can be made up locally at little cost.

The system was engineered primarily for bus and truck maintenance. Realizing that there are gasoline, diesel and mixed fleets involving all types of service, it's tough to set up a system that exactly fits every operation. Despite this, it is quite remarkable how little "tailoring" is needed to get a good fit.

Here's how the system works.

Record Folder

An 8½-in by 11-in manila folder is used for each vehicle or piece of equipment. It serves two purposes. All four faces are printed with forms in which essential data is recorded. Secondly, it serves as a file to hold all other records pertaining to the unit.

The index tab on the folder lists the equipment number, make, model, year, and date purchased. One of the printed form on the front face extends this data with a breakdown into components. You have all the data on the engine or the transmission, etc., to facilitate parts ordering. Capacities are also included.

You'd expect that lubrication would come in for considerable attention; there's no more important part of preventive maintenance. There is space for a lubrication service record covering 100,000 miles of operation. Five basic services are spelled out and there is room for four additional, specific to the piece of equipment. There is also a place to record lubrication exceptions applying to the individual unit.

Monthly fuel and lube oil usage together with the miles traveled can be recorded. Here is the basic data needed to keep tabs on engine condition, reflected in increased consumption. Just watch the "Miles per Gal" and "Miles per Qt" columns.

As parts replacement is made and dimension become non-standard, such data is recorded. There is also space for parts numbers of key components. Additional forms are provided to keep battery and tire records.

Finally there is space for the vehicle's history. Record is made of major overhauls and repairs, accessory items installed, and such items as repainting, body repairs, etc.

All entries are simple and require only a few minutes to make. When you get through you have a concise, comprehensive record of the vital statistics on each piece of equipment. Combined with the work sheet and the control black board, you've got your finger on the PM program.

Work Sheet

As service operations and inspections come due (you can tell this from the control board) the work sheet is

Inside of record folder breaks down record into components.

SOCONY MOBIL OIL COMPANY, INC.
TRUCK AND BUS PREVENTIVE MAINTENANCE WORK SHEET

GROUP A SERVICE ... MILES
GROUP B SERVICE ... MILES
GROUP C SERVICE ... MILES
OTHER SERVICES
SPECIAL REQUIREMENTS
OMIT ITEMS

WORK ORDER

ITEM NO.	CHECK HERE O	CHECK HERE X	DESCRIPTION OF WORK TO BE DONE	WORK DONE BY	TIME SPENT HOURS	TIME SPENT MIN.	RATE	AMOUNT
			TOTAL HOURS AND TOTAL LABOR COST					

PARTS AND MATERIALS USED

ITEM NO.	PART NO.	QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT

the back of the form is used. It spells out the work to be done and has the necessary columns for cost accounting. Below this is a form for listing parts and materials used. This also provides for cost accounting. A take-off of the parts and materials used in the fleet, totaled over a period of time, would make a good basis for setting up usage factors.

Control Board

Take a 4-ft by 8-ft sheet of ¾-in plywood, coat with blackboard paint, get a sign painter to letter and stripe it and you're in business. Column headings are shown.

You have to set up the mileage periods at which each service is to be performed. These are a matter of equipment types and their customary type of service. For example, they would vary between a light pickup truck and a tractor-trailer combination. Also, they would vary on the same piece of equipment if one was used in short-haul stop-and-go service and another in sustained over-the-road hauling.

There's plenty of help available here. Engine and equipment builders will study your operation and make recommendations. As far as lubrication goes, the oil company will do the same thing. Laboratory analysis of used oil samples give a good indication of whether the oil-drain period is too short or too long. It's also a basis for setting up filter change schedules.

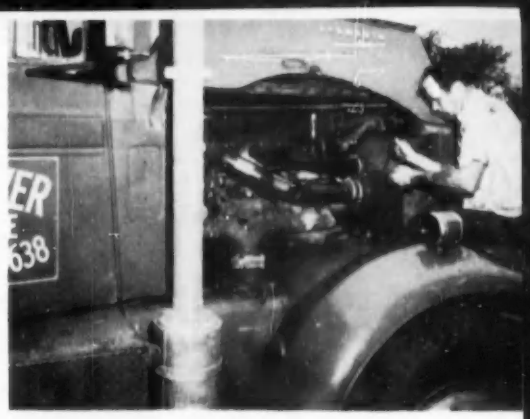
When you arrive at your mileage periods they are set at the head of the appropriate columns. Now let's start the system as of Monday morning. Enter the total mileage on each piece of equipment opposite its number. Then by simple addition you can arrive at the mileage when each service is due. These figures are entered. Total mileages are changed at the beginning of each week and so by comparison you can tell when each service is due. Overdue service can be marked in red chalk for emphasis. Once the service is performed, a new "due" figure is entered.

Conclusion

You *have* to have a PM system. Its only function is one of control to see that all necessary service is performed on time. This means the keeping of essential records. If you elaborate beyond this point, it is wasteful of time and effort. Furthermore, the simpler you keep an adequate system, the better your chances of having your records maintained and up to date.

In setting up a system you will be smart to use all the expert and "no cost" assistance that you can get. The system outlined here is a very practical one. With some tailoring it will fit most operations while using the forms available. In any case, the principles apply and can be put to use in any type of service. With construction equipment, for example, "hours" could be substituted for mileage and appropriate line-items entered under the group headings.

Don't forget, you need a PM system. And here's one that's ready-made.



Field-Installed Supercharger Helps Solve a Problem

TRUCKING involves problems. In the Los Angeles area, Weaver Hay Co. was receiving an excessive number of violation citations for smoke pollution. This area is particularly sensitive to exhaust smoke because of the "smog".

The Weaver fleet tightened up their maintenance to the highest point that seemed practicable. Engines were kept in peak condition, which made considerable differance in the smoke problem.

Driver training was also stressed. Emphasis was put upon keeping the vehicle from "lugging" by means of getting into the correct gear at the right time.

This combination helped. Most of the time engines performed well without noticeable exhaust. But certain severe conditions still made them smoke occasionally.

In January, 1955, Weaver installed a McCulloch Supercharger on one of their trucks in an effort to improve engine breathing. Before long, four additional units had been installed.

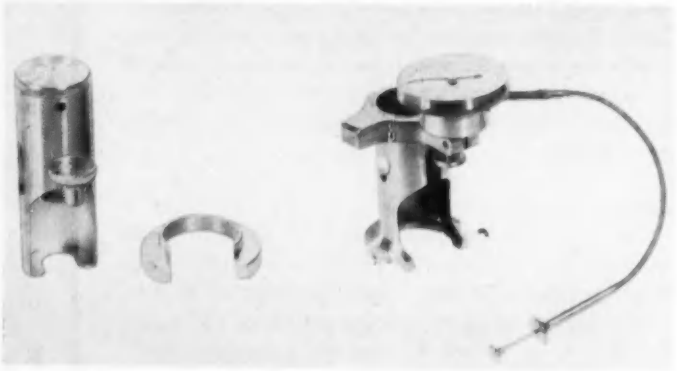
Now the results can be evaluated. Not one of the supercharged trucks has received a citation and the engines showed improved performance—especially at higher altitudes. The superchargers provide more margin for difficult operating conditions.

Supercharging results in better fuel utilization. It pumps extra air into the engine—air with additional oxygen for complete and more efficient combustion. This eliminates a cause of smoking.

The McCulloch Supercharger is a relatively small accessory. It can be installed and repaired in numerous shops, and if necessary replaced in a few minutes time. If road trouble should occur, drive-belt to engine can be removed and engine will operate with normal aspiration.

Simplicity of installation on existing engines has shown appeal to other fleet owners as well. It is a practical means of improving performance by field conversion.

Precision Setting of Valve-Lash



Valve-gapper, designed for ease and accuracy of valve-lash adjustment, has been improved.
New version combines broader utilization with lower cost.

MODERN engines leave little margin for error in their valve lash setting. As an example, just .002-in excessive valve clearance on many engines will delay opening of the valves an equivalent of 7° crankshaft rotation.

In earlier years, valve clearances were not so critical. Engines were low-speed and relatively insensitive. But with modern high-speed, high-compression engines, exact valve clearances are vital to efficient operation.

If the valve clearances are set too loose, not only will it effect the timing; but a high seating impact can occur. Tappets may not be riding the cam ramps designed to ease the valve to its seat. On the other hand you may like the quiet operation of a tight setting, but there is a good chance of leakage at the seats with consequent valve burning. Mix the clearances on the plus and minus side and you will get rough operation.

That is why P & G originally produced a valve-gapper. Each tool was designed to service usually one make of engine; but recent redesign and refinement have broadened its application. It can now be used in conjunction with adapter sets. These different sets, when added to the basic unit, make the same tool applicable to a number of different engines.

Universal model 300 consists of a basic unit with a variety of adapter sets. The former may be used with any engine, the latter are interchangeable. Different sets conform to the rocker assemblies of different engine groupings.

Basic unit consists of dial indicator, outer barrel, brake cable, spring and pin. It is packed in a protective case that has room to hold up to three adapter sets. These consist of the various inner barrels, base adapters and other components needed to fit the basic unit to the different rocker assemblies.

This means that it is only necessary to buy one basic unit. The series of relatively inexpensive adapter sets make it possible to use the same tool on several engine makes. Thus, utilization of the tool is increased by a much greater range of application, and expense is minimized. It is also accurate and easy to operate.

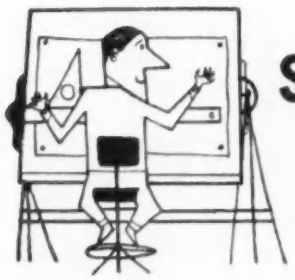
Basically, the P & G valve-gapper consists of two telescoping finely-machined barrels. The outer barrel fits around and over the valve-spring retainers. Inner barrel fits around the valve stem, hooking under the rocker arm. An internal spring exerts upward pressure on this inner barrel. The pressure lifts the rocker arm away from the valve stem during the time the valve is closed. Dial indicator operates off this vertical motion, which is the true tappet clearance.

The model 300 valve gapper may be used with engine either hot or cold, idling or stopped, according to recommendations. It is positioned on the engine (done with one hand) where spring pressure and the design of the base hold it in place. It will not fall off.

Now the adjustment locking nut may be loosened. Rocker arm adjusting screw is turned down until all lash is removed. This stops all movement of the dial indicator. Rim of the dial is then turned until the hand is at zero. Adjusting screw is backed-off until indicator hand shows the correct clearance.

If this is being done while the engine is idling, the indicator hand will oscillate between zero and the point of clearance. Any change in valve gap setting can be seen clearly on the dial as it is made. A special maximum-clearance brake (the plunger attached to dial-indicator) is used to hold the indicator hand at the point of maximum clearance. This gives an easy reading even at fast idle.

Model 300 achieves uniform and correct clearances on all valves, even if rocker arms have hollowed-out spots. Time required is considerably less than with feeler gauge technique, and the human element of individual "feel" is eliminated. This, coupled with increased utility at lower cost should make this tool a valuable addition to any maintenance shop.



service section

Recent engine and equipment modifications, procedures and recommendations straight from the different manufacturers to you

TD-24 Air Cleaner Cup Capacity

It has come to our attention that improper quantities of oil have been used in servicing the under-hood air cleaners of the 241 Series TD-24 crawlers.

The torque converter tractors with air cleaners having a bead on the oil cup as a level mark require 13 pints.

Torque converter tractors with the later type air cleaner showing the oil level on the splash baffle require 10 pints of oil. Make sure splash baffle is in place in the cup when checking the level.

The oil level mark on either type is correct and will indicate the proper volume of oil. The later type air cleaners have the lower removable element supported to the center tube of the body by a wing nut. In the older type this element is supported by the tray in the oil cup.

Thermostat Cleaning on 6L - 6N Series Waukesha Engines

The accompanying diagram shows simple pipe tool for the disassembly and reassembly of vernatherm type thermostats for cleaning purposes.

The following instructions will provide additional service from this type of thermostat, used in the Waukesha 6N and 6L series.

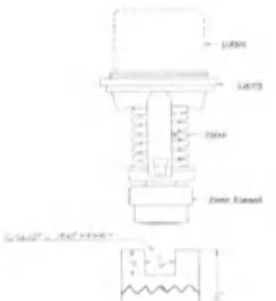
A—Slide tool over power element. Place in vise, compress the spring and remove the two straps.

B—Remove from vise, lift off valve plate and pull piston.

Note: When removing piston see if small rubber disc is stuck to inner end. If so, be sure to include rubber disc when replacing piston.

C—Clean piston with crocus cloth, lubricate with Lubriplate 105V and replace piston in guide.

D—Reassemble thermostat. This service does not change adjustment.



Alco's Inspectostat—A Maintenance Aid

Alco recently announced a temperature-sensitive device which, when installed on Model 244 and 251 engines with series lubricating oil systems, will indicate if the lubricating oil temperature was ever higher than the allowable maximum since last re-set.

This thermostatic device fits into a well that is put into the lubricating oil piping between the strainer at the lube oil cooler outlet and the main bearing header.

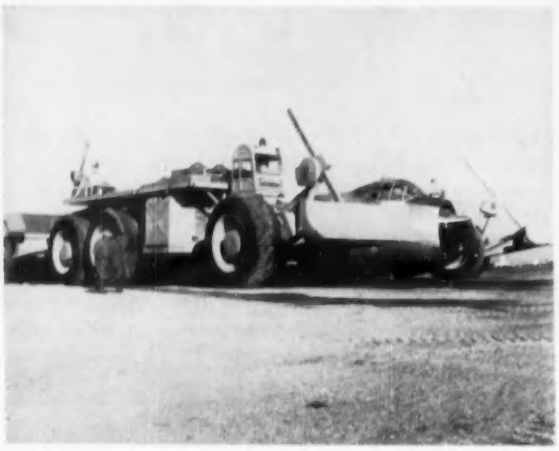
It does not ring a bell or turn on a light. It trips at a temperature of 210°F. and remains in that position until re-set. When inspecting (this should be done periodically at maintenance points), a cap is removed from the stem which extends from the side of the Inspectostat body. The knurled knob at the end of the signal plunger will then be exposed. If the device has not been tripped, the knob will stand approximately 1/16-in away from the end of the guide sleeve. In tripped position the knob will bear against the sleeve end.

If there is a tripped indication, it is certain that the lube oil temperature has been too high. This should be a signal to look into the condition of the lube oil cooler, or the water temperature settings, or for other conditions that may have affected the water or lubricating oil temperatures. To re-set, pull out as far as possible the knurled knob attached to the signal plunger.

The material required to make installation may be ordered as follows: Description — Inspectostat Cat. No. 1630031; the type of locomotive and lube oil system will determine which one of three weldolets is required—

Cooler Discharge Pipe O. D.	Size	Cat. No.
2½-in	¾-in x 2½-in	1639489
3-in	¾-in x 3-in	16394810
3½-in	¾-in x 3½-in	16394811

news of our industry

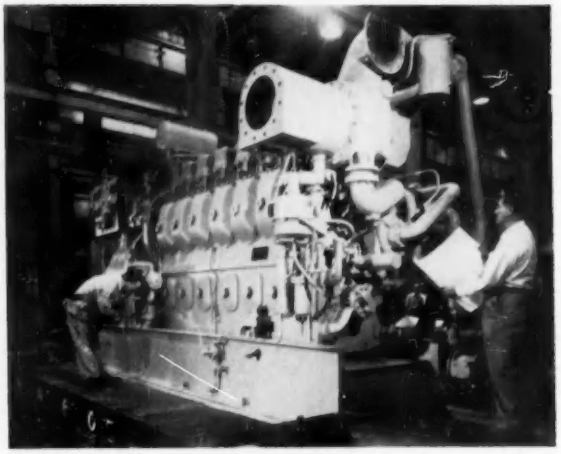


Crashed Bomber Bulldozer

Delivered to the U. S. Air Force are what R. G. LeTourneau claims are the world's largest and most powerful bulldozer-type machines. They're designed for use during emergency operations to clear runways of crashed bombers. A pair of them are said to be powerful enough to remove a 400,000-lb bomber in less than 20 minutes; the same task formerly requiring from 5 to 15 hours with conventional equipment.

Built around the same functional components and using the same fundamental design of the giant machines LeTourneau is noted for, the new mammoths operate through diesel-powered high-torque electric motors. Each of its six wheels has a motor geared directly to it, making every one an independent drive unit though they are all designed to work together. If one or more wheels should lose traction, the portion of horsepower load is automatically transferred to the other wheels. A regenerative braking system has been built into the equipment which is also supplied with mechanical brakes for parking and emergency conditions. Steering is by an electrical switch.

The 151,000-lb machines are over 67-ft long, 17-ft high, and 13-ft wide. They travel on 10-ft high, 4-ft wide tires weighing more than 2500 lb apiece and which have a ground contact area of almost 1500 sq in each. The tubeless tires are also claimed to be the world's largest and can operate on as low as 5-lb air pressure. Size of the crash pusher is shown here compared to two walking men at the left and also to a B-36 bomber. The second machine is just visible beyond the bomber's nose. Note that each has a blade and operator's cab at both ends.



Alco's First AC Diesel Power Package

A new incinerator plant in the town of Oyster Bay, Long Island in New York is the first recipient of Alco Products, Inc. new alternating-current, diesel-electric power set. The skid-mounted unit is powered by the recently introduced Alco 251-B, a 6-cyl, lightweight, heavy-duty, turbocharged engine designed for both stationary and portable application. At this particular installation, the engine is rated for 690 bhp at 900 rpm.

The engine-generator set requires a 20-in concrete foundation, which Alco states is more than 52 inches under the amount of concrete required for many units with the same or lower ratings. The lighter foundation has been made possible by distributing the set's weight over a large bearing surface, making the unit load under 1000 lb per sq ft. No stress is claimed to be applied to the foundation by the package design.

The other element of the package is a 495-kw AC generator with top-mounted, belt-driven excitation. The unit has self-contained lube oil, fuel oil, and shell-and-tube jacket water cooling systems. It will be used as the main power source at the start of each operating week at the incinerator installation until steam pressure and operating temperatures are attained for a turbine-generator unit. After that it will be on hand for emergencies.

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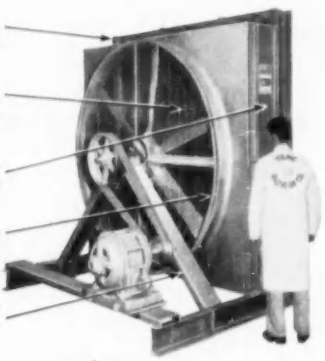
5 WINNERS in a Row!

Five Straight REA Champions Served by Young Coolers

Five years in a row Young Radiator Company Cooling Units have contributed to the efficiency of champion REA plants! These winners were equipped with Young "MonoWeld"® Jacket Water Coolers (described below) and Young space-saving Aftercoolers. Wherever Diesel engine heat transfer such as this is involved, Young has the experience and the *proved performance record* to bring you a new high in engine efficiency . . . deliver more cooling . . . use less valuable horsepower to do it! That's just part of the Young story. Call or write for further details today.



Extremely rigid steel channels support core sections and plenum chamber mountings.

Readily replaceable unit core sections. Vertical tubes boost core strength.

Gas and lube oil cooling coils may be used between fan and liquid cooling core.

Special roll-formed fan ring and fan location provide maximum efficiency.

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A New Concept in *FULL-FLOW* Filters...

ENGINE LIFE *Maxiflo*

UNRESTRICTED CORE

DESIGNED TO GIVE MAXIMUM FLOW AND FILTRATION

Conditions oil without restricting flow

Here's a brand new ENGINE LIFE exclusive that gives unrestricted oil flow without sacrificing strength. This new core development which required research and development of special machines and tooling right in our own plant, gives you the finest full flow oil filtering yet. Now, even the most viscous lubricating oils and fuels are filtered perfectly. Because core openings can handle up to 10 times the oil pumped through the system, the most excessive surges are easily handled, thereby protecting the hydraulic system from undue restriction and ultimate failure. All integral parts of the new Maxiflo core are of non-corrosive metal.

New core perforation, instead of removing metal from openings, keeps all the metal pronged to give element structural strength and prevent filter media from sagging
ENGINE LIFE

With Maxiflo, as in all Engine Life Elements, consistency in diameter and length is maintained

ENGINE LIFE elements operate without impairing the hydraulics of your engine. Better oil conditioning is achieved through the ENGINE LIFE absorption method of full filtration. All ENGINE LIFE elements are engineered to meet requirements of your application.

ENGINEERED FOR ALL REQUIREMENTS

Lubrication system flow rates are maintained by the free area ratio of perforation. Openings equal up to 10 times amount of oil volume pumped through engine.

Non-corrosive Metal Cores are end sealed with metal rings to insure trueness, add lip strength.

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EL MONTE, CALIFORNIA

ENGINEERED FILTRATION SERVICE

INDUSTRIAL AUTOMOTIVE MARINE & AGRICULTURAL

Straight from the Tool Box

This is YOUR Department. Pass along your ideas to the other fellow. Send items to the Editor, preferably with a picture or sketch. Contributors will receive $10.00 for each item upon publication.

Torquing Hard-to-get-at Nuts

Walter Allen, Milwaukee, Wisconsin—I want to begin by saying I know it is best to use a torque wrench when tightening engine nuts and bolts. The trouble is, what can you do if you can't get a torque wrench on a few of them?

Here's what I mean. Many times you will have a head nut under or so close to rocker assemblies that you can not get to it. On another, you may be able to get the torque wrench on it, but then find you don't have any room to swing the wrench. When I run into this, and am in too much of a hurry to take off the rockers, here is what I do.

There will be several other head nuts that you can get at. Take these one at a time. Loosen the nut, and then retighten it finger-tight. Put the torque wrench back on the nut, and count the number of turns you need to bring it to the right torque.

After doing this to a few to get an average, you know that the same number of turns will bring the others to the same torque. Now you can use an open-end or a box wrench to bring them down.

All nuts and bolts should be torqued. Some, such as head bolts, are more critical than others. Overtightening can very easily cause distortion.

Your procedure is a valid one. Tightening the nut a specified number of turns will pre-stress the stud accurately, providing your average number of turns is reasonably correct. When this is the case you would get very close correlation to the readings you get from your torque wrench. But also remember the pattern of tightening. After establishing the number of turns needed, loosen all nuts and pull them down in their proper order.—Editor

Radiator Exterior must be Clean, too

Joseph Avery, Yuma, Arizona—Last month's Tool Box had a letter that talked about keeping the cooling system clean. It was all right as far as it went, but getting the heat from the engine to the cooling water is only half the job. Nobody seems to say very much about the other half, that is, getting heat from the cooling water to the air.

Our trucks go through some pretty rugged running. At regular intervals we run them into the shop and with an air hose blow bugs, leaves and all kinds of things from between the radiator tubes. They load-up fast in the Summer. These things, if left where they were, would interrupt the flow of air through the radiator and cut it down to where the radiator would merely recirculate hot water.

We also make a point of washing-down the outside of the radiator whenever it begins to look dirty.

While we have the truck in the shop we also look at the fan and the fan belt to see that they are in first-rate condition. Water pumps are checked, too. Sometimes these will not be working properly, and you will look for a half-dozen other things before you find the real trouble.

Sorry. We should have mentioned it, too. Dissipating engine heat from coolant to air is a very important function of cooling. To do this efficiently you need a clean system both inside and outside, and other components must also be functioning properly. This is especially true in view of the number of power-accessories hung on modern tractor-trailers. These accessories cause higher average loads, therefore a heavier burden to the cooling system.—Editor

news of our industry

A-C Forms Credit Corporation

A new company, Allis-Chalmers Credit Corp., has been set up to assist in financing sales of Allis-Chalmers machinery. Initial application will be to the firm's tractor group to supplement sources of bank and other credit now available.

Hyster to Open Scotland Plant

Plans to establish a tractor equipment assembly plant near Glasgow, Scotland, on the Clyde River, have been announced by Hyster Co. The new plant, whose operations will start this fall, will supplement the company's manufacturing plant set up in Nijmegen, The Netherlands, in 1952.

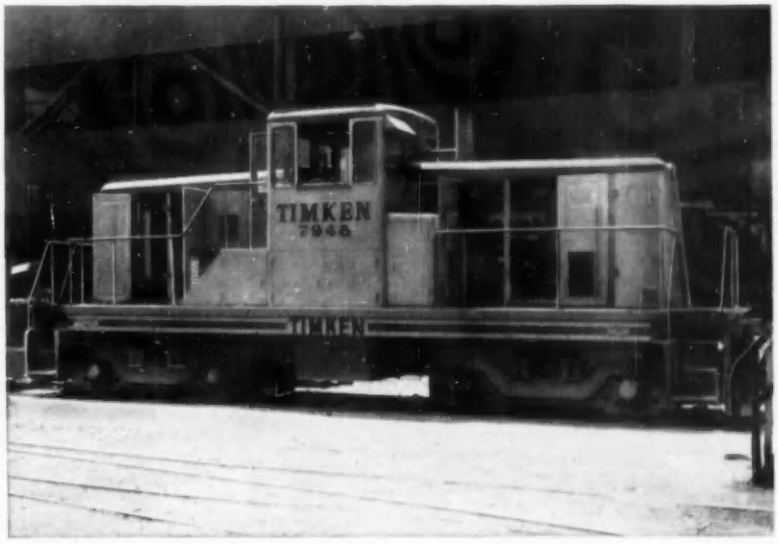
This marks the third expansion for the materials handling firm to make the news. A second industrial truck plant is being erected in Danville, Ill. to supplement the original factory opened in 1946. And a 25,000-sq ft addition is also scheduled at the Peoria factory which makes tractor equipment and mobile cranes.

Steamer Becomes Museum Item

A 41-year-old Alco steam locomotive, believed to be the last coal-burning 10-wheeler in the U. S., has taken its place at the Shelburne Museum as a memento of the past. The locomotive, formerly owned by the Central Vermont Railway, has been placed alongside the last of the nation's sidewheel steamboats, the "Ticonderoga".

Nostalgia-wise, the coal burner was built by the American Locomotive Co., now Alco Products, Inc., in 1915. It was known as "Old 220" on the Central Vermont and had the informal title, "Locomotive of the Presidents". In 1920 it pulled a special train that carried the Duke of Windsor, then the Prince of Wales, from Connecticut to Montreal. Later it powered special trains carrying Presidents Calvin Coolidge, Herbert Hoover, and Franklin D. Roosevelt.

TURBO-CHARGING IS NOT NEW AT HERCULES!



2 HERCULES TCD's*

24,242 hours of service in 39 months

Since March, 1953, two Hercules 6-cylinder TCD's have been providing dependable and economical power for this 80 Ton G. E. Diesel-Electric Yard Locomotive #7948. Operating in the melt shop of The Steel and Tube Division, The Timken Roller Bearing Company, these two Hercules TCD's are establishing new records for continuous trouble-free service.

According to log sheets kept by the Timken Company's locomotive shop foreman, this equipment has operated 24,242 hours since it was put in service. Moreover, these hours have been logged under adverse conditions of extreme dust and heat, 24 hours a day, seven days a week for an average of 621 hours a month. Because of this record of performance this locomotive has been nicknamed "Old Reliable" by the men in yard. "Old Reliable" has been serviced under the Timken Company's preventive maintenance program. The TCD's were overhauled at approximately 14,000 hours and will have almost that many hours before the next overhaul.

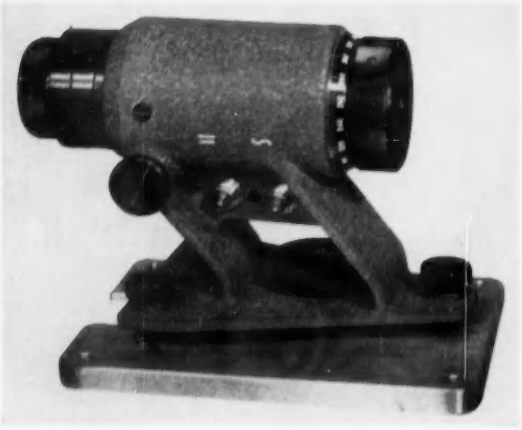
Other applications of Hercules TCD's such as busses, generator sets, mine cars, marine applications, etc., have established similar record of power and performance. Yes, Turbo-charging is not new at Hercules. TCD is just a new name for a tried and proven product.

*Turbo-Charged Diesel

HERCULES MOTORS CORPORATION

CANTON, OHIO

new products



Piston Displacement Indicator

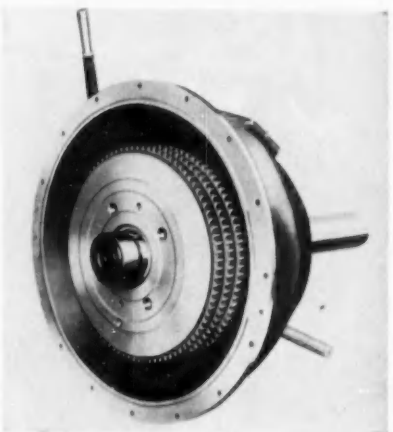
Direct display of cylinder pressure-volume on an oscilloscope instead of the usual P-T diagram is now possible with Swiss-developed indicator being marketed by Kistler Instrument Co. It is an electro-static device which connects to the engine shaft, and functions according to an electro-static charge on a variable capacitor. A standard "Piezo-Calibrator" amplifier is used to couple the unit to the oscilloscope.

This approach allows use of the instrument for very slow engine speeds and permits static calibration so that piston displacement can be indicated even when the engine is stopped. The amplitude of the signal is independent of engine speed. A precision dial is provided to adjust the instrument to any desired cylinder.

Heavy-Duty Power Transmitter

Twin Disc Clutch Co. has made an addition to its SP line of heavy-duty friction power takeoffs designed to meet the increased power transmission requirements of higher speed, higher horsepower industrial engines. The new takeoff, the SP-321, can handle up to 6370 lb-ft of torque and transmit up to 602 hp at 1550 rpm.

It is available with a standard SAE No. 00 flywheel housing adapter to meet the widest range of industrial power units in its hp and rpm ratings. Other features include a triple driving plate construction to provide ample friction surfaces to withstand excessive heat, a pilot bearing with double width bearing race for greater lubrication retention and bearing life, and a spherical roller bearing at the clutch output shaft for greater overload and side pull capacity.



Mechanical Malfunction Detector

Anticipation and prevention of trouble on all types of rotating equipment is the function of this Model 5 Vibraswitch available from The Beta Corp. Responsive to slight increases in roughness or vibration, it effects shutdown before complete failures occur. Examples of detectable malfunctions are failing bearings, bent shafts, unbalance, broken blades, and the like. Applications are to engines, compressors, test stands, motors, etc.

The monitor's actuating mechanism is said to be completely fail-safe. An electrically operated, shock-free reset and holding mechanism is incorporated to prevent actuation from starting vibration, or transient shocks. No power is required except for starting so that power failure does not prevent actuation. It may be used singly, in pairs on driver and driven equipment, or in series to monitor each bearing. Range is up to 18,000 rpm.

new products

Wet Surface Grinder

Tillis Mfg. Co. has designed a wet surface grinder which takes work up to 42-in high and 72-in long. Though planned for the automotive service field, the new Model 117 can be used for jobs in production and in the tool shop as well. It is said to hold to tolerance of 0.0002 in. Feeds on both the spindle and table are automatic, and full cycle may be completed without an attendent. The head raises and lowers by geared motor. The coolant tank is wheel-mounted and the spindle is mounted on angular contact ball bearings.

200-Hp Motor Scraper

A 14-cu yd heaped-capacity motor scraper has been introduced by Allis-Chalmers. Weighing approximately 39,600 lb, the new TS-260 is powered by a 6-cyl, 200-hp Buda diesel. Positive drive and constant power for steering and scraper operations are provided by a hydraulic pump, gear-driven from the rear of the engine crankshaft.

Designed into the new machine is selective hydraulic steering, providing 2-speed steering by action of a steering control valve actuated from the wheel by direct linkage. A 30-deg turn of the wheel right or left directs full hydraulic power to double-acting steering jacks for full 90-deg steering. When slower turning action is wanted on fast hauls, a slight turn of the wheel permits a regulated pump flow for slow response. Synchronized 4-wheel air brakes, plus an emergency brake system which activates on air line failure, are other features.

STANDARD OF THE INDUSTRY SINCE 1936

Luber-finer

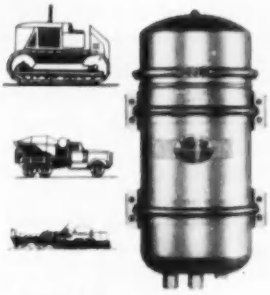
FOR EVERY TYPE OF ENGINE EVERY TYPE OF OIL

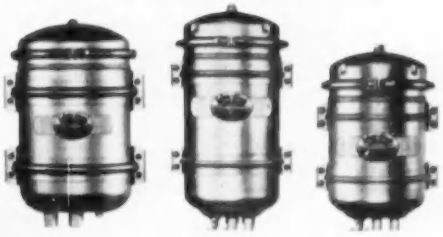
STANDARD and OPTIONAL EQUIPMENT ON LEADING DIESEL TRUCKS TRACTORS & STATIONARY ENGINES

Only a Luber-finer Filter Unit with a genuine Luber-finer Pack produces the patented filtering process that gives engineered protection to engine and oil as recommended by equipment manufacturers. The vital oil supply is circulated through Luber-finer's exclusive specially processed media which removes not only the injurious suspended solids from the oil but also the colloidal impurities which are often more damaging, thus increasing the life of both engine and oil. *The Efficiency of Luber-Finer's Patented Process has never been equalled!*

Luber-finer's patented filtering process adds thousands of miles to engine and oil life—cleaning—filtering—and returning the oil to the engine with the excellent lubricating qualities as specified by the manufacturers of today's modern high powered engines. Every minute—every mile your engine is run it must be protected.

Remember, there's a Luber-finer model especially designed for your type of engine or oil.





DON'T BE MISLED! ONLY GENUINE LUBER-FINER PACKS GIVE EXCLUSIVE ENGINEERED PROTECTION

DIESELPAK — Designed for use with H.D. detergent compounded oils. May also be used with fuel oils and straight mineral oil. Removes impurities and contaminants—without affecting the additives.

REFINING PACK—Designed for use with straight mineral oils, fuel oils, hydraulic oils and inhibited industrial oils.

The Refining Pack, which combines ABsorbent with ADsorbent filtration, removes acids, moisture, suspended particles and colloidal impurities during its effective life more efficiently than any other filter.

WRITE FOR COMPLETE INFORMATION DEPT. 5

LUBER-FINER, INC. 2514 S. Grand Ave., Los Angeles 7, Calif.

SAVE MONEY ON DIESEL UPKEEP

free booklet tells how . . .

THIS illustrated booklet contains a wealth of sound, practical ideas to expedite Diesel maintenance, keep operating costs low and extend equipment life. Gives details on such subjects as:

- Cleaning filters
- Desludging lube oil coolers
- Descaling jacket water coolers
- Degreasing engine parts before repair
- Steam-detergent cleaning
- Plant maintenance cleaning

Booklet also discusses tested Oakite procedures for streamlining maintenance in steam control stations and electric power plants.

FREE copy of this 44-page booklet yours on request. Consult your local Oakite Technical Service Representative. Or write address below. No obligation.

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news of our industry

Vapor Heating Buys Rubber Co.

The purchase of Roth Rubber Co., manufacturer of molded mechanical rubber products, has been announced by Vapor Heating Corp. The acquired company has been a supplier of high temperature rubber parts for Vapor's train heating equipment. Gaskets, made of silicon rubber materials, for diesel engines are some of the major products of manufacture to be continued by the new division of Vapor.

Traveling Laboratory

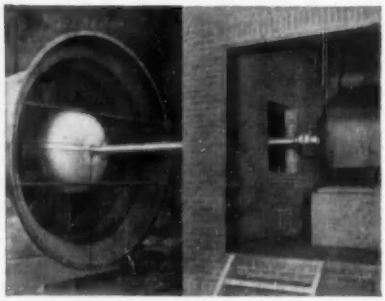
Brush Electronics Co. has readied its "laboratory on wheels" for tour again. The station wagon will feature field demonstrations of the newest instruments for sound and vibration measurement plus a new line of instruments used for strain measurement. As in the past, actual demonstrations will be made according to a company's operating needs at its own plant site.

Gas Turbine Power For Canada

Canadian General Electric Co., Ltd. has sold the British Columbia Power Commission what is believed to be one of the world's largest installations of gas turbines for the generation of electric power. Four gas turbine-generator units with a total of 75,500 kw have been ordered and will be installed in a power station in the city of Alberni, which is near the east side of Vancouver Island in the vicinity of Victoria.

The order is for two 19,750-kw single-cycle, single-shaft units and two 18,000-kw regenerative-cycle, single-shaft units. They will have 50°F inlet temperatures at 200 ft above sea level and a top speed of 910 mph. Air will travel through the turbine compressors at 314 mph. Each turbine will drive a 3-phase, 50-cycle, hydrogen-cooled generator turning at 3600 rpm and producing 13,800 v at 60 cycles. The plant will be in operation in 1957.

Eliminate Intermediate Bearings !



By using Thomas Flexible Couplings on long, unsupported shafts, intermediate bearings are eliminated. Thomas engineers tubular shafts free from lateral whip.

The large fan shown above is 16' from the motor to allow sufficient air intake. Miners working underground receive their fresh air supply from this fan and others like it, which have been giving dependable service for as long as fifteen years . . . without shutdowns for lubrication or maintenance of the couplings.

Thomas floating shaft flexible couplings are recommended for machine and marine drives, printing presses, paper and cement mills, cooling towers, diesel engines, pumps, compressors, and many other uses.

Only Thomas Flexible Couplings offer *all* these advantages

UNDER LOAD and MISALIGNMENT

1. Freedom from Backlash—Torsional Rigidity
2. Free End Float
3. Smooth Continuous Drive with Constant Rotational Velocity
4. Visual Inspection in Operation
5. Original Balance for Life . . . *and*

Thomas All Metal Couplings have No Wearing Parts so Lubrication and Maintenance are Eliminated

Write for Engineering Catalog 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

news of our industry

Management Change at DEMA

Effective next January 1st, Harvey T. Hill retires as executive director of the Diesel Engine Manufacturers Assn., after 13 years of service. In anticipation of this event, Robert L. Stanley, the organization's educational director, has been elected corporate secretary and will take over Mr. Hill's functions when the retirement is finalized.

Mr. Stanley came to DEMA on a fulltime basis toward the beginning of 1953, to serve as educational director. He had previously been in a consultative capacity. He brought a background of experience in both the classroom and laboratory to this post, having both taught engineering courses and engaged in engineering research.

H. T. Hill

R. L. Stanley

GM Improves 110

A side-mounted Roots blower now takes the place of the rear-mounted centrifugal unit formerly installed on the Detroit Diesel 110 Series diesel. Similar to the one used on the Series 71 models, the new blower has made the engine more compact and cut down its height. It also has increased the number of available accessory drive outlets on the rear of the engine.

There are now four accessory drives on the rear and four fan-mounting positions on the front of the engine. Other achievements of the new blower include the availability of the engine with either right- or left-hand rotation. It also provides an increased air supply to the cylinders for better combustion.

morco Factory-Certified Exchange Crankshafts give Trouble-Free Operation for the Full Life Cycle of Your Diesel Engine

morco dealers—coast to coast—are stocked with reconditioned, like-new crankshafts for different diesel engine models. Users of Detroit Diesel and Cummins engines can exchange worn shafts for MORCO factory-reconditioned shafts through authorized dealers.

Why take chances? Let your dealer be your source for dependable, safe crankshaft regrinding. You get immediate service, guaranteed quality and terrific economy. Ask your dealer about MORCO today.

..Look what morco's complete reconditioning service offers you!

MAGNAFLUX six separate magnaflux inspections with latest equipment.

GROUND on production type equipment to engine manufacturers' specifications. Original stroke retained.

TOCCO* HARDENED by the original equipment method when necessary.

ROLLED FILLETS increase strength at the most critical areas.

DYNAMIC BALANCE restored on original factory balancing equipment.

THRUST COLLARS and surfaces restored.

GEAR FITS renewed.

KEY WAYS restored.

DOWEL HOLES repaired.

OIL SEAL surfaces renewed.

THREADS repaired.

*TOCCO is a registered trademark of the Ohio Crankshaft Co.

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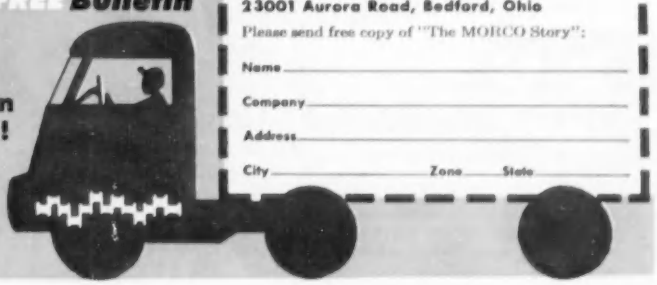

MORCO, Inc.—Dept. 1
23001 Aurora Road, Bedford, Ohio
Please send free copy of "The MORCO Story":
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Company _____
Address _____
City _____ Zone _____ State _____

Spray-Form Flaw Detector

Magnaflux Corp. announces that it has simplified the use of its dye penetrant inspection equipment by placing all required materials in self-contained pressurized spray cans. Portable kits are now available for the tradenamed Spotcheck system. These consist of various allotments of penetrant, developer, and cleaner in the new spray cans.

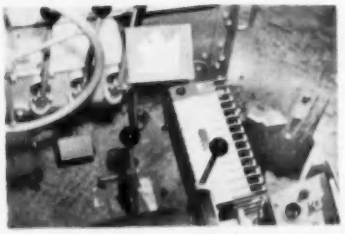
Hydraulic-Lift Work Platform

For production and maintenance work above ground level, Ballymore Co. is producing a portable work platform. In its lowest position, it is 5-ft above the floor and can be raised up to 10 ft above that. Power supply is an option of a ¼-hp electric motor, battery-operated motor, or hand pump.

A double rack and pawl holds the 33-in by 7-ft, 3-in platform at working height. Access to the platform is by a telescoping built-in ladder. The steel structure is mounted on four swivel ball-bearing casters, and a screw-type jack at each corner allows stability on uneven floors. Rated load is 1250 lb. A 3-ft handrail provides protection along the longer side.

Hot Water Heaters for Cats

As attachments for its Nos. 12, 112, and 212 motor graders, Caterpillar Tractor Co. is making available new high-output hot water heaters. Each is equipped with two individually controlled blower fans capable of providing an air output of 620 cfm. Their rated capacities are approximately two and one-half times that of the previously used small single-fan heaters. They may be ordered to match either 6- or 24-v electric systems.



Full-Flow Filter Cartridges

Briggs Filtration Co. has designed a "super-flow" replaceable line of filter cartridges for engine lube and fuel oil applications as well as other uses where high flow rates are desired. They are being nationally marketed to fit almost any commonly used industrial or automotive filter case.

The element consists of resin impregnated paper which has been formed into uniform layers and accordion-pleated to multiply the filtration area. It is secured to a perforated metal center tube whose ends are anchored to top and bottom plate, a cork gasket on each end giving seal and strength when cartridges are stacked one upon the other. The cartridges are wrapped in a treated paper covering to protect the pleated paper.

Basic characteristics include low pressure drop and fine particle selection, the water-proof paper making the cartridges suitable for water emulsion coolants. They are designed for 98% plus initial particle removal to 15 microns, with progressively finer filtration as solids accumulate.

The World's Leading Manufacturers of FUEL INJECTION EQUIPMENT for Diesel Engines

C.A.V.

Depots and Service Agents in over 100 Countries

C. A. V. FUEL INJECTION EQUIPMENT DIVISION of LUCAS ELECTRICAL SERVICES, INC.
Head Office: 653 Tenth Avenue, New York 36, New York
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AP 174-755

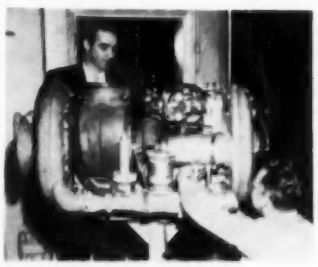
new products

Nylon Sling

To assure scratch-free handling of highly finished or soft materials, Caldwell Co., Inc. is producing Liftex, a nylon webbing sling, treated to resist grease, abrasion, alcohols, alkalies, salt water, and various solvents. Constructed without rivets or metal, the product is claimed to have the following advantages: high strength combined with low weight, fast and complete recovery from shock loads, and low moisture absorption. Models with lifting capacities up to 13,500 lb are available.

Turbine-Compressor Advance

"The closest approach yet made to a commercial gas turbine compressor set, with reliability, manufacturing cost, and maintenance costs competitive with existing commercial standards", is Boeing Airplane Co.'s summation of its newly developed gas turbine-powered centrifugal compressors. The units are now in production for the U. S. Air Force as air starters and are also being made available to operators of jet transports. Other uses are for checking out aircraft pneumatic power and air conditioning systems.



The new 502-11B's embody design simplifications and improvements which are the result of four years of research. The number of compressor stages has been reduced from two to one. At the same time, air hp output has been increased to 210, which is 70 air hp more than the earlier 2-stage 502-7D units now in service.

Castings in the basic turbine unit have been reduced from 18 to 7. Impeller design simplification has halved this item's production cost. Accessory drives and burner and nozzle details have also been simplified. The new units incorporate automatic starting systems and combination spark and glow plugs.

An advanced rotor bearing and balance system has been developed which make use of a "floating slipper thrust bearing". This is expected to reduce bearing costs and increase their service life. The new bearing is said to have greater thrust-load capacity at high speeds than conventional precision-type ball bearings. This would remove previous limitations to higher efficiency centrifugal compressors by permitting higher speeds and pressure ratios. The slipper bearing also allows a degree of automatic adjustment for errors in alignment and balance, for smoother running. Present balancing procedures are not expected to be necessary.

SPECIALLY ENGINEERED FOR DIESEL ENGINE REBUILDING SERVICE

TOBIN-ARP MFG. CO.
Announces the NEW

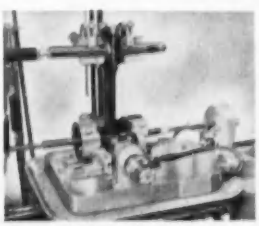
PM 900D PIN FITTING MACHINE

SPECIALLY ENGINEERED TO PRECISION BORE

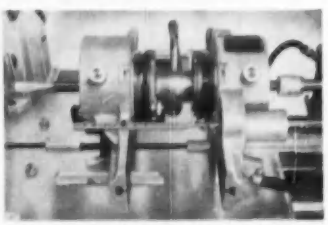
The PM 900D is a precision boring machine—capacity 21/32" to 2⅜". Connecting rod capacity 23". Boring capacity can be increased to 4⅛".

√ CONNECTING ROD BUSHINGS
√ CAM LEVER BUSHINGS
√ ROCKER ARM BUSHINGS

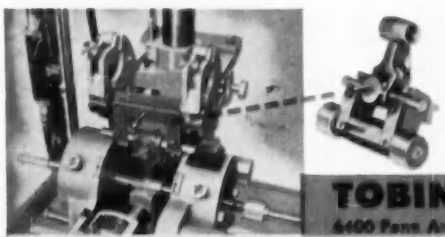
A TAMCO PRODUCT



1 Precision boring piston pin bushing parallel with crank pin bore, to specified center-to-center dimension.



2 Precision boring rocker arm bushings in less than one minute per rocker arm.



3 Precision boring cam lever bushings, parallel with roller shaft to specified center-to-center dimension, with Vernier Scale Control.

Write TODAY for complete information!

TOBIN-ARP MFG. CO.
6400 Penn Ave. S. • Minneapolis 23, Minnesota

organizational news

Taking Over at Detroit Diesel

is Clyde W. Truxell. Formerly works manager of the GM division, he succeeds Semon E. Knudsen to the post of general manager. He's been working on GM's diesel development programs since 1932.

C. W. Truxell

After a Distinguished Career

of more than 35 years with the Electric Storage Battery Co., Dr. L. E. Lighton, vice president and director of research, is retiring from office. He is shown handing over his project file to Capt. Clifton G. Grimes, USN (Ret.), who is succeeding him.

Newest Appointment

at Enterprise Engine & Machinery Co. is Irving Halpern who is taking on the position of supervisor of research and development. He most recently occupied the spot of senior research engineer.

Irving Halpern

Here's Why

PERFORMANCE IS BETTER WITH Bendix STARTER DRIVES

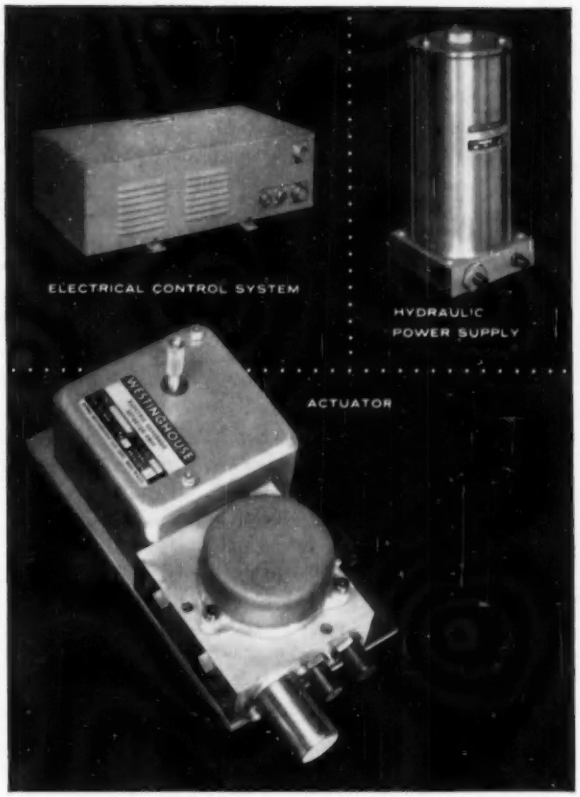
CHECK and COMPARE THESE FEATURES

- Starting motor can be mounted more easily and in more positions.
- Requires no actuating linkage—solenoid can be placed in any convenient position.
- Simple in design—has fewer parts—needs fewer adjustments.

It takes a truly outstanding product to receive over 100,000,000 endorsements. Yet, that's the number of Bendix Drives that have been installed. No other starter drive approaches this record of outstanding performance. That is why, whatever your type of diesel or whatever its purpose, it will pay you to specify Bendix* Starter Drive for the most economical installation and dependable performance. *REG. U.S. PAT. OFF.

ECLIPSE MACHINE DIVISION of Bendix AVIATION CORPORATION
ELMIRA, NEW YORK

Export Sales: Bendix International Division, 205 E. 42nd St., New York 17, N.Y.



PRECISE...

new Westinghouse electric governor anticipates speed changes

An electric load-sensing element in the new Westinghouse electric governor anticipates speed changes . . . brings the fastest, most precise control ever known to engine-generator sets. Typical recovery time on a full-load transient is less than one second!

Designed for Diesel and gasoline engine driven generator sets from 30 kw through the largest sizes; 50/60 cps. or 400 cps. Designs are available to meet full military environmental requirements. Consists of rugged, hydromechanical actuator system and electrical control unit . . . has no electronic tubes. Provides for paralleling two or more units with zero speed regulation.

For more information, send coupon below. J-21965

WATCH WESTINGHOUSE

*WHERE THE **FUTURE** IS **ALREADY** IN PRODUCTION!*

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organizational news

Named as Manager
of original equipment sales for the air filter division of the Dollinger Corp., is Harold D. Cupitt. He was with Air-Maze Corp. for the past three years.

H. D. Cupitt

Heading Industrial Sales
at Joy Mfg. Co. is John P. Cartwright. He will be succeeded as Washington district manager by Arnott J. Lee.

Dallas Branch Managership
for Cooper-Bessemer Corp. is now in the hands of R. F. Bartlett. He's been with the company since 1933.

F. N. Perry

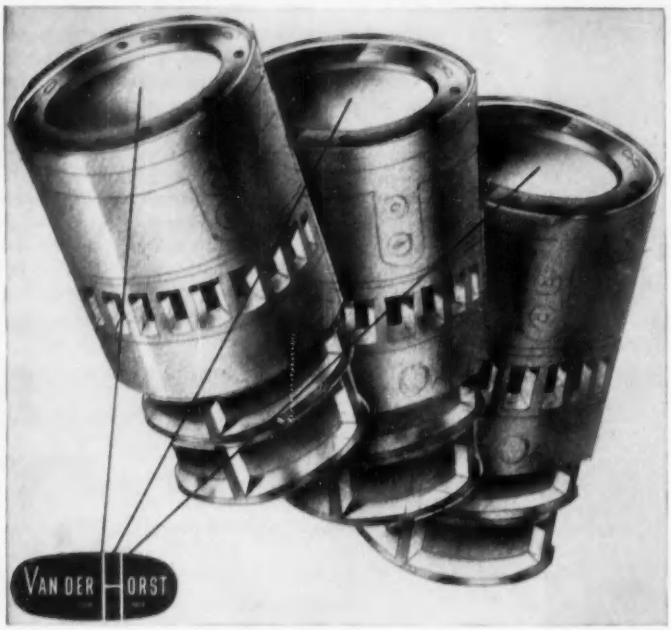
Special Representative
in the U. S. for Robert Bosch Gmbh is the newest appointment for Foster N. Perry. He had previously been associated with American Bosch, serving there for 32 years, the last five as executive vice president. His work now includes cooperation with the German company's subsidiary, Robert Bosch Corp. of New York.

District Sales Representative
is the entering post for E. C. Schum at Amot Controls Corp. Formerly diesel engine sales manager of the Hamilton Div. of Baldwin-Lima Hamilton Corp., he will now be covering southwestern Ohio, southern Indiana, and Kentucky.

E. C. Schum

Joining as Sales Manager
at Packless Metal Hose Inc. is Murry B. Johnson. He was previously with Warner-Patterson and Permutit Co.

5 *big advantages of*



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news of our industry

See Diesel Boom Abroad

Diesel locomotive exports this year should break all records, according to a report by the *Journal of Commerce of N. Y.* Growing foreign industrialization is making the expansion and modernization of railroads vital to handle the increased traffic. The World Bank and the Export-Import Bank are also helping improve the transport situation by increasing their financial aid.

U. S. diesel manufacturers are geting the benefit of these increased locomotive purchases so that diesel exports, this year, it is estimated, will be much larger than last year's $24 million worth.

The Electro-Motive Div. of GM is expected to deliver more than 200 complete locomotives overseas, to make 1956 the best year in its export sales history. Additional orders will be filled as well by its associates in Sweden, Germany, Belgium, and Australia. A 100-locomotive backlog for delivery is the score for Alco Products, Inc., which is said to be the largest Alco has ever had. It also expects its associates in Europe to have a 25 World locomotive backlog. General Electric has a 76 locomotive order from Brazil and Chile, making 1956 its best years for diesel-electric sales.

Foresight is the reason for the major share of world orders going to American manufacturers. They developed special export models to meet the problems of foreign rails. Alco, for example, designed its World locomotive to run on any gauge while keeping its dimensions down to clear obstructions and most tunnels. The problem of dollar-short countries has been met by the licensing of foreign manufacturing associates who build locomotives to American patterns. Powering these foreign-built locomotives, however, are American-made engines. The licensees also provide servicing facilities and spare parts.

Where U. S., builders have no licensees, they have established spare

Why People Buy Diesels

(Continued From Page 35)

Starting and starting systems came in for many comments. Relative starting ability, presumably in colder weather, is apparently a factor of some importance. Also, there appears to be definite preferences in types of starting equipment although there was no indication given of the types preferred. Since electric, pneumatic and hydraulic systems are largely an option, it would appear that the individuals' preference is between these and gasoline engine starting.

A selection of some write-in comments makes a fine conclusion for us. One stated, "I think that this is a very good idea and you have started something worthwhile for users and operators. We need more of this". Apparently some people do not consider these factors at all because one person comments, "Some operators know little except brand names (these we feel sorry for)".

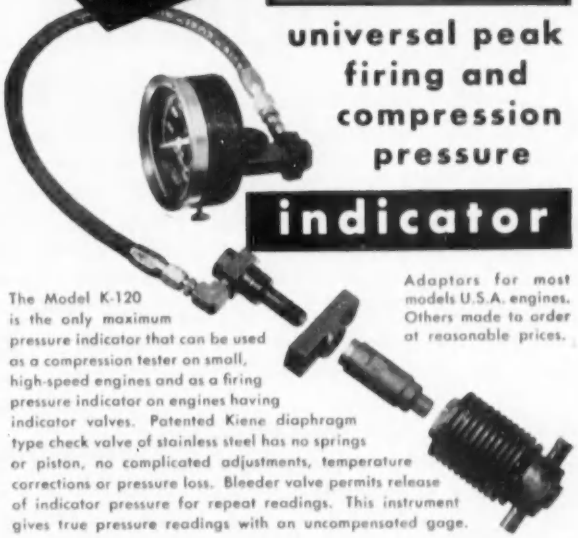
And another says, "Performance is important but is often a matter of application and so becomes a selection problem. Most engines meet their fuel consumption guarantees. Therefore, some of the other factors are the principal ones to consider. Of these, maintenance costs are most important." This, of course, is reflected in the charts.

The capper appears as a simple terse comment, "Service is the key to sales."

KIENE®

MODEL K-120

universal peak firing and compression pressure indicator



The Model K-120 is the only maximum pressure indicator that can be used as a compression tester on small, high-speed engines and as a firing pressure indicator on engines having indicator valves. Patented Kiene diaphragm type check valve of stainless steel has no springs or piston, no complicated adjustments, temperature corrections or pressure loss. Bleeder valve permits release of indicator pressure for repeat readings. This instrument gives true pressure readings with an uncompensated gage.

Adaptors for most models U.S.A. engines. Others made to order at reasonable prices.

KIENE DIESEL ACCESSORIES, INC.

10352 PACIFIC AVE., FRANKLIN PARK, ILLINOIS

news of our industry

parts depots. Another selling proof is in the fact that an increasing number of foreign railroaders are being sent to the U. S. to learn diesel maintenance. This forefront in foreign sales is expected to be maintained for quite a while. There are more than 100,000 steamers still in service overseas. And with deliveries so far measuring in the hundreds, the foreign market has hardly been scratched.

Welding Advisory Service

Eutectic Welding Alloys Corp. has set up an advisory service through its more than 350 district engineers. It offers the results of a survey of present and possible welding operations in each industry. The service includes demonstrations to bring welders up to date on special welding applications such as color matching, repairs without dismantling, and preheating. It also offers suggestions for adapting improved techniques to difficult base metals.

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new literature

A Supervisor's Safety Manual

has been published by the National Safety Council, to provide foremen with a comprehensive guide to all phases of industrial safety. Material includes accident prevention, first aid, protective equipment, housekeeping, materials handling, machine guarding, portable power tools, and fire prevention.

Power Transmission Machinery

is the subject of a 328-page catalog covering the complete line of products manufactured by Dodge Mfg. Co. Helpful information includes section drawings, dimensions, weights, prices, application details, and engineering tables.

Alco 251 Diesels

the company's new family of engines, are detailed in a 14-page bulletin. The series includes a 6-cyl in-line model and 12- and 16-cyl vee-type engines rated from 550 to 2400 hp. Individual components and cross-section cutaways are featured along with dimension charts and specification tables.

Specifying Relays

is the title of a 12-page article published by American Machine & Foundry Co. It goes into the various factors that should be considered in selecting an electrical relay for a given application.

Modern Practices in Plant

maintenance and engineering are contained in a book reporting on the proceedings of the latest conference on this subject, produced each year by Clapp & Poliak, Inc., who also publish the book. This year's book, seventh in the series, has 248 pages which include 110 illustrations, charts and tables. It contains the text of 16 papers, summaries of 15 round-table discussions, and answers to 1100 specific questions.

Ion Exchange Equipment Users

will be interested in Publication 5813, describing Cochrane Corp.'s Hydromatic valve used in the control of demineralizers, zeolite softeners, dealkalizers, and pressure filters. It is said to eliminate the complicated nest of individual valves required to control various stages of service, backwash, regeneration, rinse, and return to service.

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- Diesel Compression Testers
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- Cummins Injector Tester
- International Harvester Injection Testers
- General Motors Injector Testers
- Injection Pump Calibrating Stands
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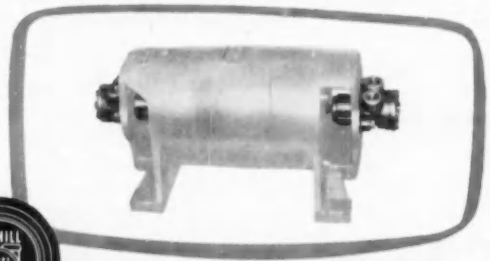
Write for Catalog No. 101 for complete details.



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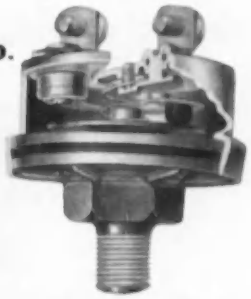

DESIGNED FOR HEAVY DUTY USES

The new, rugged and dependable RMC #2900 Series Vacuum Switch is designed for service on vibrating equipment. The mechanism is sealed dust-proof and watertight. The spring loaded diaphragm is Buna N impregnated and is calibrated at the factory to close or open a contact at fixed vacuum values.

Designed for 6, 12 or 24 volts DC, but available for low voltage AC. Double or single terminal, ⅛" or ¼" center back connection. SEND FOR SAMPLE for inspection and test.

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PRESSURE SWITCH

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new literature

A Hydraulic Hose Selector

is being offered free to users of its rubber-covered control hose by the Republic Rubber Div. of Lee Rubber & Tire Corp. It contains latest SAE and industry specifications. Starting with a known factor such as ID, OD, bend radius, etc., the selector can be used to determine the proper hose needed.

In the Works for Truckers

is a sales managers manual, the first of its kind contemplated for the entire trucking industry. It will cover such subjects as selection of motor freight salesmen, training, motivation, measurement practices, sales production plans, development of an internal selling plan, and gaining top management support.

Diesel Trucks and Tractors

of the White Motor Co.'s White-Freightliner Div. are described in a new series of literature. Specific models are dealt with singly, each fully detailed with chassis diagrams, dimensions, and specifications.

60-Cycle Generators

of 400 kw, 500 kva, are described in a new brochure offered by Kato Engineering Co.

Instruments for Smog Study

are covered in a new booklet available from the American Soc. of Mech. Engineers. Believed to be the most complete of its kind assembled, the publication lists hundreds of devices useful in studying air pollution along with manufacturer name and address. Items range from simple filter papers to electrostatic precipitators. It sells for $2 a copy.

Large OD Thin-Wall Tubing

produced by Superior Tubing Co. are now described in literature which is claimed to be the first available on this type of product. Tubing in sizes from ⅝- to 2½-in OD, and with wall thicknesses of .035 in and less, are detailed.

Safe Feeds and Speeds

for high-speed drills used on various metals have been listed in a chart offered by Chicago-Latrobe.

Over 1000 Models

of construction and industrial equipment available with Detroit Diesel engines, as standard or optional power, are listed in a reference booklet just released by this GM division. The listed models range from small pumps to giant excavators. Over 150 manufacturers are represented.

To Build Offshore Platform

Another portable offshore drilling platform for Zapata Off-Shore Co. of Houston is being designed by R. G. LeTourneau, Inc., with delivery scheduled for early 1957. The first is currently drilling its second well in the Gulf of Mexico.

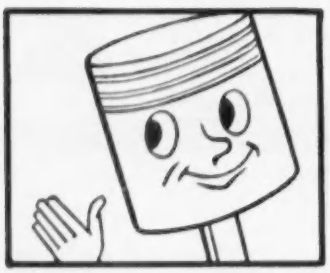
The new platform will be larger than the first (see DIESEL POWER, July 1956), and will incorporate a number of improvements. In operation, the machine will lower its legs to the bottom of the Gulf and within a 2-hr period, will have elevated its deck to the height of a 10-story building above the ocean's floor. Upon completion of the well, it will lower itself to the water, lift its 145-ft legs, and move on to a new location.

The triangular platform will weigh 3 million lbs. Its three legs will be operated by gearmotors, nine per leg, which will also hold the platform at any desired height. On top of one leg, a helicopter landing area will be located. Each leg will have a large tank at its base to serve as feet for the platform, cup-shaped to grip the ocean floor.

The deck will be over half an acre in size to accommodate housing for a 45-man crew, supply storage areas, two deck-mounted revolving cranes, and three anchor windlasses. The interior of the 20-ft-deep hull will house most of the drilling equipment and the diesel engines, generators, and necessary drilling materials.

Powering the electric elevating system and also supplying ship service power for the platform will be three 600-hp diesel engines. A separate set of diesels will furnish power for mud pumps, drawworks, and other drilling machinery.

TRIPLE PLAY AT FLOOD TIME



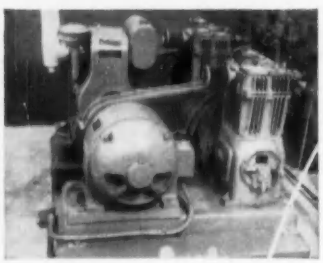
by Cecil Diesel

ROVING REPORTER

OAKLAND, CALIF. — The place: a storm water pumping station. It's been raining for hours. Will streets flood and cause costly water damage? Listen for the triple play.

Diesels start purring . . . pumps start pumping . . . and Quincy Model D340 Compressors start humming. Here's what's happening. Flood water level rouses four pump-driving Enterprise DSG-318 Diesels to action. Then as tank air pressure drops below 220 pounds, Quincy Compressors automatically start . . . build pressure back up.

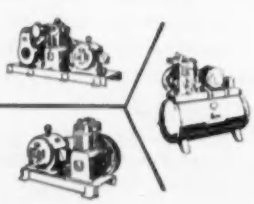
As one Oakland city official puts it, "We're so sure those Quincys will always start, we don't even have an attendant here." Even if all electric power would fail, gasoline-powered Quincys start the diesels anyway . . . and supply air for controls.



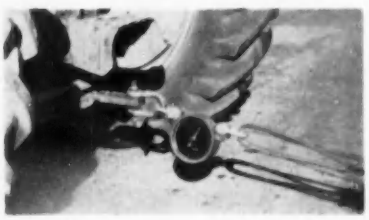
And there's a Quincy Compressor for every diesel starting job. Let Quincy help you select the right model from a range of mountings and sizes — from 1 to 90 CFM. Write them for a catalog.

Quincy COMPRESSORS

QUINCY COMPRESSOR CO.
DEPT. J-50, QUINCY, ILLINOIS



World's finest air compressors

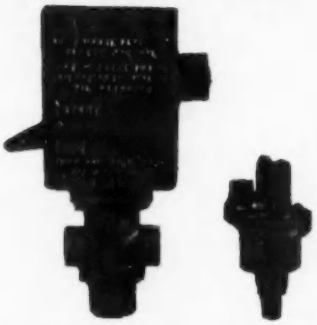


Measuring Tractor Drawbar Pull

The amount of drawbar pull delivered by a tractor determines its basic efficiency. W. C. Dillon & Co., Inc. believes that its portable-traction dynamometer is a conclusive means of checking such power since it instantly indicates the amount of drawbar force exerted in pounds.

In the illustrated test, the dynamometer was positioned in series between a farm tractor and a large semi-trailer of 37,500-lb dead weight. Conducted from a standing start, braking force was gradually applied by the trailer until the tractor engine stalled. When circumstances do not permit the use of another vehicle, Dillon suggests that the equipment under test be dead-ended to any secure anchor point and load applied until either the engine stalls or there is a loss of traction.

AMOT SAFETY CONTROL



AMOT Model 1476-47 automatically shuts down engine on high water temperature or low lube oil pressure. Features are:

1. **No capillary tube and bulb used.**
2. **Uses well known AMOT element.**
3. **Several temperature sensing units can be used with one control unit.**
4. **Will operate an air whistle.**
5. **Will operate a diaphragm gas valve for large gas engine shut down.**
6. **Will operate as a diesel fuel shut off valve.**
7. **Available with 2" direct connected gas valve.**

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news of our industry

More Whites to Spanish Base

The new U. S. Air Force in Spain will be receiving an additional 27 Superior diesel generating units to raise the total of engines ordered from the White Motor Co. to 42. Earlier this year, an order had been made for 15 diesel pumping units to drive jet and diesel fuel through product pipe lines. Both orders are scheduled for December 1956 completion.

The 27 additions will provide a total of 6200 kw. They'll be working in radar stations and pipeline pumping stations linking various air bases. Sixteen of the units will be 392-hp Model 40C-SX-6 diesels supplying 250 kw each. Six of the others are Model 40C-SX-6 diesels rated at 292 hp. The remaining five are Model 40C-S-6 units of 290 hp. These last 11 will provide 200 kw each.

All will operate on diesel fuel delivered in the same lines which supply jet fuel to the air bases. The 15 pumping engines of the previous order will be 325-hp Model 40C-SX-8's. They and 11 of the generating units will be installed at six pumping stations situated at varying altitudes across the country. One of the advantages to be gained in using only Model 40's is interchangeability of parts.

Caterpillar to Raise Capacity

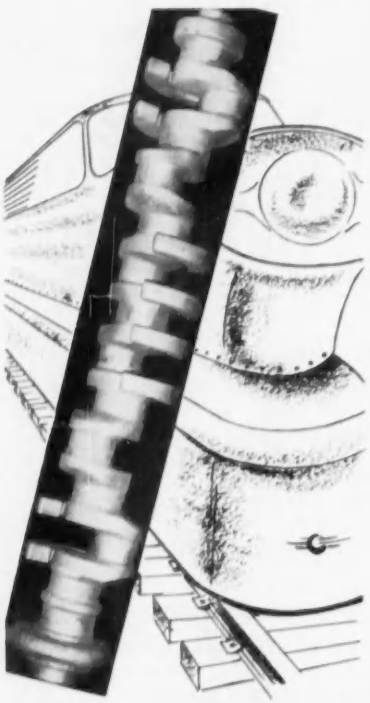
Another step in its recently announced program to provide increased productive capacity at all plants to meet the growing needs of its customers has been reported by Caterpillar Tractor Co. Early in 1958, the operations of the Peoria Parts Dept. will be transferred to a new building in Morton, Ill. The space vacated at Peoria will be returned to manufacturing operations by the addition of machinery and equipment, to increase the plant's production of crawler tractors and diesel engines.

Surfacing Aluminized Valves

Applying a protective aluminum-iron alloy layer to the working faces of engine valves extends their life from two to three times above that of a conventional valve made of the same material. It provides a protective film which inhibits attack on the base metal.

The problems involved in finding an economical method of applying this coating were disclosed to engineers at the recent semi-annual meeting of the ASME, by engineers of Thompson Products, Inc. The new development now significantly reduces production coating costs to put it within the reach of all engine builders.

The previous technique involved a costly process of valve heating in a fluxing salt, dipping it in molten aluminum, and passing it through an air blast to remove the excess. The new process consists of induction preheating, aluminum spraying, and induction postheating.



PARK "DIE-FORGED" CRANKSHAFTS

help power the trains of tomorrow

The new entries in the lightweight train race are designed to solve the problem of mounting deficits in passenger operation by cutting original, operating and maintenance costs.

Park Drop Forge is proud that Park "Die-Forged" Crankshafts are specified for the diesel engines that power these trains of tomorrow.

HEAVY DIE FORGINGS SINCE 1907

Diesel Crankshafts up to 4000 lbs.
Crankshafts and Connecting Rods
Aviation and Marine Drop Forgings

THE PARK DROP FORGE CO.
Cleveland 3, Ohio

What Do You Know!

(Answers to Questions on Page 46)

1. Most correct order is "c, b, d, a". A DIESEL POWER survey of an "Industry Board" of 325 men selected from our readers affiliated with engine and equipment distributors, service and repair shops, and municipal and utility plants placed these factors in this order. See Page 34.

2. Correct answer is "a". The stall characteristics of gas turbines produce high low-speed torques. See article on Page 36.

3. Correct answer is "a". After many years of use in Europe, free-piston engines show less sensitivity to different fuels. GM has successfully operated them on fuels ranging from 100-octane gasoline to crude oil. See article on Page 36.

4. Correct answer is "a". The length of the piston stroke is varied by changing the amount of fuel injected or a change in the bounce chamber pressure. See article on Page 36.

5. Correct answer is "a". Because of great amounts of heat lost with exhaust gases, thermal efficiency is about 15 to 16%. When exhaust heat is recovered to produce steam, etc, overall thermal efficiency of unit is about 70%. Regenerators can raise thermal efficiency from 15 to about 20% but power output is lowered. See Page 48.

6. Correct answer is "b". The best location is where the tail-pipe is twice as long as the exhaust pipe, according to tests. A very good location is where the tail-pipe is ¼ as long as the exhaust pipe. See article on Page 51.

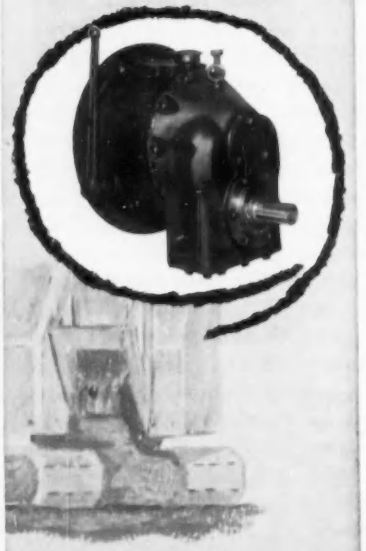
7. Correct answer is "b". Systems of keeping maintenance records should be as simple as possible so they can be quickly and clearly understood and have a better chance of being carried out. See Page 57.

Longer
Work Time
Keeps Your
Profits...UP
with

S-N
REDUCTION GEARS

POWER A DIESEL OR GASOLINE INDUSTRIAL ENGINE with S-N REDUCTION GEARS and Power Cut-Off Clutch

Regardless of the type of heavy duty equipment you are powering . . . there's a S-N Model and gear ratio to do the job — faster, and more economically. Seven models available. Remember S-N Reduction Gear Units insure smooth, full power from engine to load with maximum economy. Ideal for original equipment and all types of engines from 40 H. P. to 750 H. P. giants. Reduction ratios start at 1.5:1 and step-up to 4:1 in standard ratios. New catalog sheets are available.



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For details write R. S. NORRIS & ASSOCIATES
LARCHMONT, New York

new literature

Three Scraper Catalogs
have been issued by Euclid Div., General Motors. They describe the overhung engine line: Models S-7, S-12, and S-18. Each is illustrated by cutaway views of major components and contains full engineering data.

Self-Locking Fasteners
of one-piece construction, the complete line of Nylok Corp., have been catalogued. A variety of applications are detailed.

Wrought Iron Fittings
and flanges produced by Tube Turns are described in a data folder discussing the physical properties of the material and illustrating typical applications.

Hydraulic Research Activities
have been compiled from reports by various hydraulic and hydrologic laboratories in the U. S. and Canada, and copies are now available from the National Bureau of Standards. Called Miscellaneous Publication 218, the volume runs to 216 pages and sells for $1.50.

Industrial Hose and Fittings
manufactured by Aeroquip Corp., are described in a condensed catalog prepared to facilitate ordering of parts.

Lubrication Systems
custom designed and in packaged units, are described in an illustrated bulletin prepared by Dravo Corp. Typical installations are illustrated.

Maintenance and Repair
procedures for its line of standard alternators, which are designed for use on vehicles where maximum battery output is required, are detailed in a step-by-step picture folder by Leece-Neville Co.

Air Control Valves
of every type manufactured by Airmatic Valve, Inc., are detailed in a 72-page catalog. Each 2-, 3-, and 4-way valve type for high- or low-pressure use is handled separately.

Commemorating its 50th Year
of industrial truck production, Elwell-Parker Electric Co. has produced a brochure describing its six new truck lines. It also illustrates the "world's first industrial truck ever built", which was introduced by the firm in 1906.

USE BELL
INJECTOR CUPS and TIPS
STANDARD AND 21° FOR THE LEADING TRUCK DIESELS
Years of proven service
Volume production on automatic machines means SAVINGS
We pass this on to the consumer
Sold by all parts houses
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Point Indicator

To reduce computing and layout time in joining, shaping, drilling, and milling operations, Racine Instrument Co. has come out with an instrument it calls the Miracle Point. It actually is a combination angle-finding, center-locating, and leveling device for shop and field use.

It consists of a mercury-balanced level and degree-calibrated dial, enclosed and mounted on a magnetized vee-base. By placing the base against a surface, such as a board to be leveled or metal stock to be shaped, the device will read off the exact angle at which the work is being held within 3 minutes of a degree accuracy. The magnetized base holds the instrument in contact with metallic objects so that the worker's hands are free to adjust the work to the correct angle.

To find the center of an object such as a section of bar stock to be drilled, the indicator is placed astride it and turned until the dial reads zero. The vee-base junction then indicates the exact center. A center punch runs through the instrument to aid in marking hole locations. Points can also be located at any angle on material to be worked by placing the indicator on the object and turning until the dial reads the desired angle. The center punch then shows the correct point location.

Hand Pump Oiler

A self-contained oiling system that delivers oil under pressure to single or multiple bearing points of all types of machinery, is being marketed by Trico Fuse Mfg. Co. Said to have practically unlimited application, the new Lub-O-Jet has a pressure pump built into its 4-oz transparent reservoir.

A 6-outlet distributor is connected to the reservoir assembly. Plastic and transparent tubing is attached to the distributor outlets and run to the lubricating points which can be as much as 100-ft away, in any direction. A small amount of oil is fed to all bearings simultaneously each time the pump is stroked. All the feed tubes remain filled for the next cycle. Accessories such as connectors and clips are available for easy installation.

Cold-Repair Kit

Chain-Lock Process Co. is now marketing its patented method for cold repair of cracked or broken castings, in kit form. The method was previously available only to licensed shops.

The kit contains all tools, equipment, and instructions, necessary to repair engine blocks, heads, cylinder valve ports, housings, or any other casting. The process is said to restore the castings to as good as new condition, resistant to temperature extremes and expansion and contraction strains. It binds the two sides of a break together and then seals the crack. The repairs are guaranteed to meet insurance approval and requirements of service inspections.

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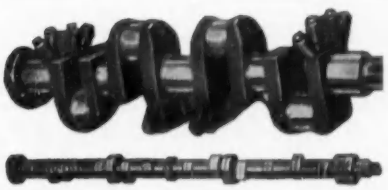

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Sturgis, Michigan, light plant management in 1946 determined that it might be difficult to satisfy all power requirements if the light plant's large engine, or more than one of its small engines, was down. The plant is equipped with 5 engines—four GM 1,600 H.P. and one Busch-Sulzer 2,475 H.P. Plant management rightly figured that one of the keys to the problem was good lubrication. So, in 1946, STANODIESEL Oil M was tested in one General Motors engine.

In 1947, based on its performance during the test, all engines were converted to STANODIESEL Oil M. In the nine years since, the plant has never had to shut down power to customers because of engine or oil failure. There have been no wear problems. Engines have stayed clean. There is no ring sticking. Bearing life is exceptional.

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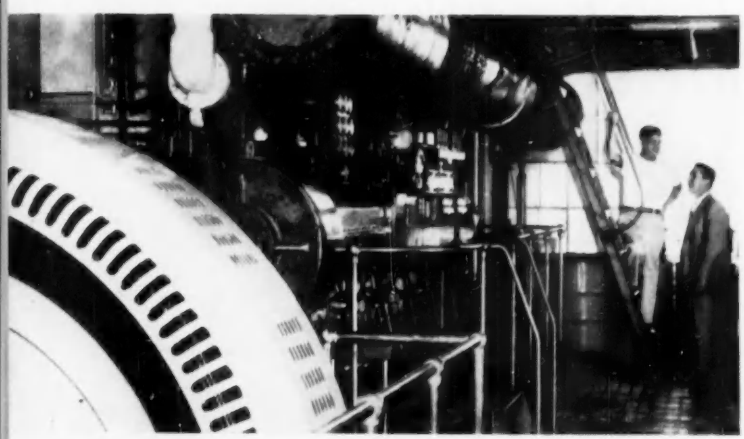
There's a Standard Oil industrial lubrication specialist near you in any of the 15 Midwest or Rocky Mountain states. Call him for more information about STANODIESEL Oil M. Or write Standard Oil Company, 910 S. Michigan Avenue, Chicago 80, Illinois.

J. J. Threlfall, superintendent and Donald Cripps, Standard Oil lubrication specialist check Don's data book on Sturgis light plant diesels. Don is well qualified as a lubrication specialist. He has been doing this work for nine years. He has an engineering degree from Michigan State University and is a graduate of the Standard Oil Sales Engineering School.



Sturgis, Michigan, light plant has four GM 1,600 H.P. engines and this Busch-Sulzer 2,475 H.P. engine. Engines receive progressive maintenance at 3,500 to 4,000 hours. STANODIESEL Oil M is used in all engines.

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